

SANYO

No. 3968

LA4589W**1.5 V Stereo Headphone Preamplifier
and Power Amplifier****OVERVIEW**

The LA4589W is a 1.5 V stereo headphone preamplifier and power amplifier IC that provides all the functions of a complete playback system in a single chip, making it ideal for battery-powered, portable cassette players.

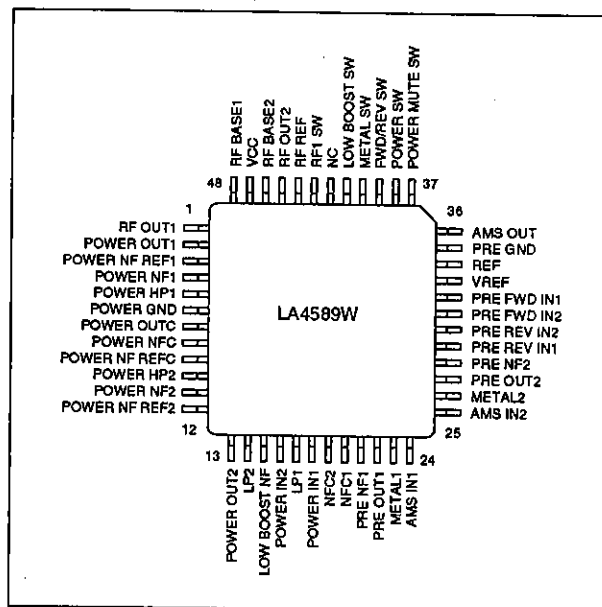
The LA4589W incorporates a metal/normal-tape equalization preamplifier, a power amplifier dual power supply ripple filters, a reference voltage amplifier that enables small-value (under 1 μ F) virtual-earth capacitors to be used, and a system controller.

The LA4589W features single-pin control bass boost and forward/reverse playback, an automatic music search (AMS) function, inputs for an auto-reverse tape mechanism, a power amplifier mute function a power switch, and selectable, single or dual ripple filter operation.

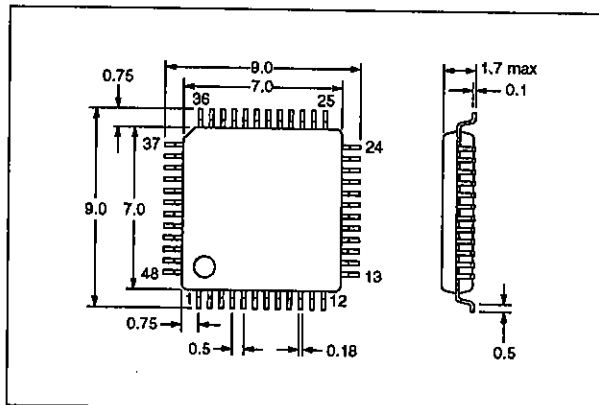
The LA4589W operates from a 0.95 to 2.2 V supply and is available in 48-pin SQFPs.

FEATURES

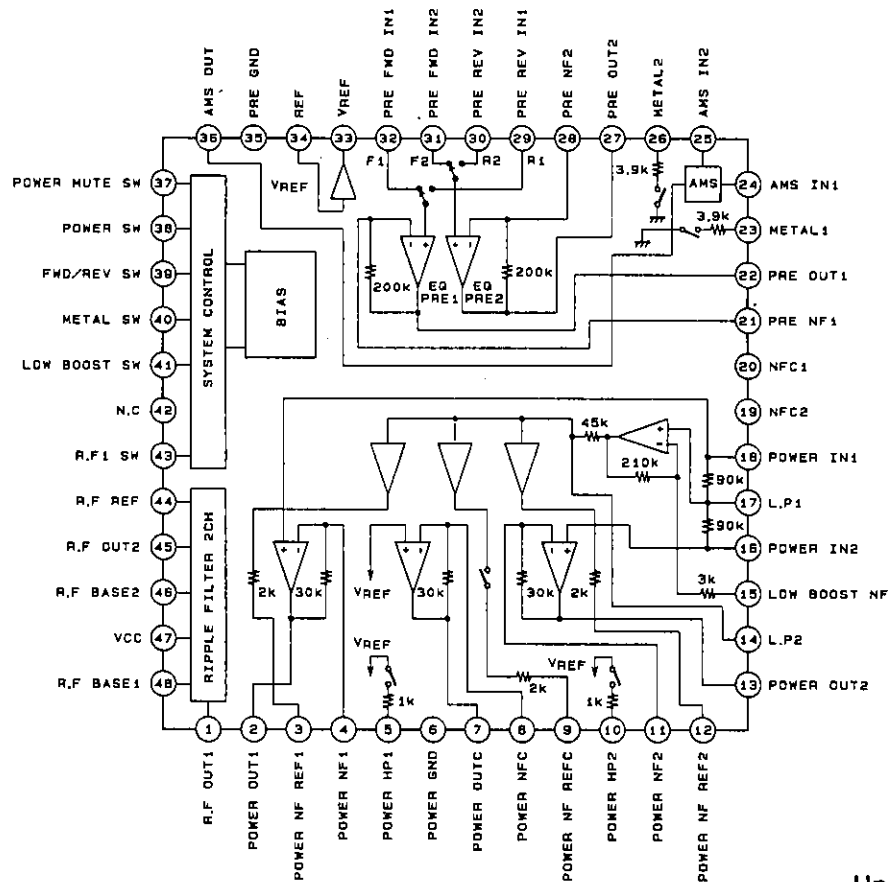
- Single-pin control bass boost
- Automatic music search (AMS)
- Preamplifier inputs for auto-reverse tape mechanism
- Single-pin control forward/reverse playback selection
- Two, on-chip, ripple filters
- Selectable, single or dual ripple filter operation
- Metal- and normal-tape modes
- Power amplifier mute function
- On-chip reference voltage amplifier
- No power amplifier output capacitors required.
- 73 dB (typ) preamplifier open-loop voltage gain
- 21 mW (typ) output power with bass boost
- Built-in noise reduction capacitors
- 0.95 to 2.2 V supply
- 48-pin SQFP

PINOUT**PACKAGE DIMENSIONS**

Unit: mm

3163-SQFP48

BLOCK DIAGRAM

Unit (resistance: Ω)

PIN DESCRIPTION

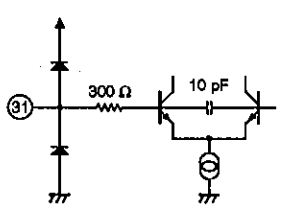
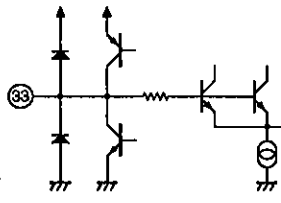
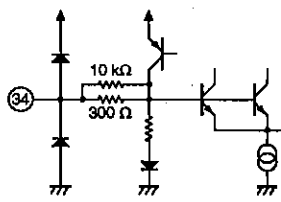
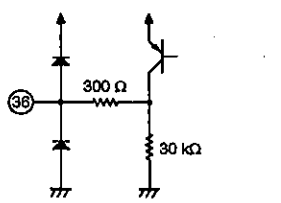
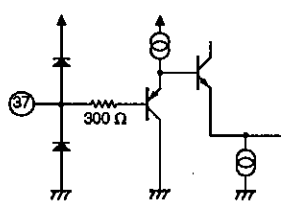
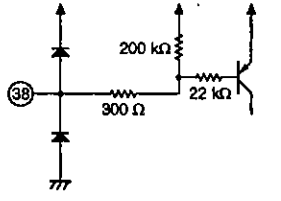
| Number | Name | Equivalent circuit | Description |
|--------|---------|--------------------|---|
| 1 | RFOUT1 | | Ripple filter outputs. Nominal voltage is 1.13 V. |
| 45 | RFOUT2 | | |
| 2 | POUT1 | | Power amplifier output 1. Nominal voltage is 0.6 V. |
| 7 | POUTC | | Power amplifier common output. Nominal voltage is 0.6 V. |
| 13 | POUT2 | | Power amplifier output 2. Nominal voltage is 0.6 V. |
| 3 | PNFREF1 | | Power amplifier output 1 negative feedback reference voltage. Nominal voltage is 0.75 V. |
| 9 | PNFREFC | | Power amplifier common output negative feedback reference voltage. Nominal voltage is 0.75 V. |
| 12 | PNFREF2 | | Power amplifier output 2 negative feedback reference voltage. Nominal voltage is 0.75 V. |

| Number | Name | Equivalent circuit | Description |
|--------|------|--------------------|--|
| 4 | PNF1 | | Power amplifier output 1 negative feedback network connection. Nominal voltage is 0.75 V. |
| 8 | PNFC | | Power amplifier common output negative feedback network connection. Nominal voltage is 0.75 V. |
| 11 | PNF2 | | Power amplifier output 2 negative feedback network connection. Nominal voltage is 0.75 V. |
| 5 | PHP1 | | Power amplifier highpass filter outputs for bass boost. Nominal voltage is 0.75 V. |
| 10 | PHP2 | | |
| 6 | PGND | | Power amplifier ground |
| 14 | LP2 | | Bass boost amplifier lowpass filter capacitor connection 2. Nominal voltage is 0.75 V. |
| 15 | LBNF | | Bass boost amplifier negative feedback capacitor connection. Nominal voltage is 0.75 V. |
| 16 | PIN2 | | Power amplifier inputs. Nominal voltage is 0.75 V. |
| 18 | PIN1 | | |
| 17 | LP1 | | Bass boost amplifier lowpass filter capacitor connection 1. Nominal voltage is 0.75 V. |

LA4589W

| Number | Name | Equivalent circuit | Description |
|--------|---------|--------------------|--|
| 19 | NFC2 | | Negative feedback capacitor connections. Nominal voltage is 0.75 V. |
| 20 | NFC1 | | |
| 21 | PRENF1 | | Preampifier channel 1 negative feedback network connection. Nominal voltage is 0.75 V. |
| 28 | PRENF2 | | Preampifier channel 2 negative feedback network connection. Nominal voltage is 0.75 V. |
| 22 | PREOUT1 | | Preampifier outputs. Nominal voltage is 0.45 V. |
| 27 | PREOUT2 | | |
| 23 | METAL1 | | Preampifier channel 1 metal-tape mode connection. Nominal voltage is 0 V. |
| 26 | METAL2 | | Preampifier channel 2 metal-tape mode connection. Nominal voltage is 0 V. |
| 24 | AMSIN1 | | Automatic music search inputs. Nominal voltage is 0.75 V. |
| 25 | AMSIN2 | | |
| 29 | PRER11 | | Preampifier reverse playback inputs. Nominal voltage is 0.75 V. |
| 30 | PRER12 | | |

LA4589W

| Number | Name | Equivalent circuit | Description |
|--------|---------|---|--|
| 31 | PREFI2 |  | Preamplifier forward playback inputs. Nominal voltage is 0.75 V. |
| 32 | PREFI1 | | |
| 33 | VREF |  | Reference voltage amplifier output. Nominal voltage is 0.75 V. |
| 34 | REF |  | |
| 35 | PREGND | | Preamplifier ground |
| 36 | AMSOUT |  | Automatic music search output |
| 37 | PMUTESW |  | Power amplifier mute control input |
| 41 | LBSW | | Bass boost control input |
| 38 | PSW |  | Power switch control input |

| Number | Name | Equivalent circuit | Description |
|--------|---------|--------------------|--|
| 39 | F/RSW | | Forward/reverse playback control input |
| 40 | METALSW | | Metal-tape mode control input |
| 43 | RF1SW | | Ripple filter output 1 control input |
| 42 | NC | | No connection |
| 44 | RFREF | | Ripple filter capacitor connection. Nominal voltage is 1.13 V. |
| 46 | RFBASE2 | | Ripple filter external pnp-transistor 2 base connection. Nominal voltage is 0.5 V. |
| 48 | RFBASE1 | | Ripple filter external pnp-transistor 1 base connection. Nominal voltage is 0.5 V. |
| 47 | VCC | | Supply voltage |

Note

Nominal voltages are measured when $V_{CC} = 1.2$ V.

SPECIFICATIONS**Absolute Maximum Ratings**

| Parameter | Symbol | Rating | Unit |
|-----------------------------|-----------|------------|------|
| Supply voltage | V_{CC} | 3.0 | V |
| Power dissipation | P_D | 320 | mW |
| Operating temperature range | T_{opr} | -10 to 60 | °C |
| Storage temperature range | T_{stg} | -40 to 125 | °C |

Recommended Operating Conditions

$T_a = 25$ °C

| Parameter | Symbol | Rating | Unit |
|----------------------|----------|-------------|------|
| Supply voltage | V_{CC} | 1.5 | V |
| Supply voltage range | V_{CC} | 0.95 to 2.2 | V |

Electrical Characteristics

Preamplifier and power amplifier

$V_{CC} = 1.2 \text{ V}$, $T_a = 25 \text{ }^\circ\text{C}$, $f = 1 \text{ kHz}$, $0 \text{ dBm} = 0.775 \text{ V}$, $R_L = 10 \text{ k}\Omega$ (preamplifier), $R_L = 16 \text{ }\Omega$ (power amplifier)

| Parameter | Symbol | Condition | Rating | | | Unit |
|--------------------------|-----------|---|--------|-----|-----|---------------|
| | | | min | typ | max | |
| Quiescent supply current | I_{CCO} | $R_g = 2.2 \text{ k}\Omega$, $R_V = 0 \text{ }\Omega$ | 8 | 15 | 24 | mA |
| | | PSW is OFF. | – | 0.1 | 5.0 | μA |
| Closed-loop voltage gain | VG_T | $V_O = -20 \text{ dBm}$, $R_V = 10 \text{ k}\Omega$ | 54 | 57 | 60 | dB |

Preamplifier

$V_{CC} = 1.2 \text{ V}$, $T_a = 25 \text{ }^\circ\text{C}$, $f = 1 \text{ kHz}$, $0 \text{ dBm} = 0.775 \text{ V}$, $R_L = 10 \text{ k}\Omega$ (preamplifier), $R_L = 16 \text{ }\Omega$ (power amplifier)

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|-------------------|---|--------|------|------|---------------|
| | | | min | typ | max | |
| Open-loop voltage gain | VG_O | $V_O = -20 \text{ dBm}$ | 60 | 73 | – | dB |
| Closed-loop voltage gain | VG_C | $V_O = -20 \text{ dBm}$ | 34.0 | 35.5 | 37.0 | dB |
| | | $V_O = -20 \text{ dBm}$, $f = 10 \text{ kHz}$, METALSW is ON. | 25.5 | 28.0 | 30.5 | |
| Maximum output voltage | $V_O \text{ max}$ | THD = 1% | 100 | 210 | – | mV |
| Total harmonic distortion | THD | $VG = 35.5 \text{ dB/NAB}$, $V_O = 100 \text{ mV}$ | – | 0.1 | 0.5 | % |
| Input noise voltage | V_{NI} | $R_g = 2.2 \text{ k}\Omega$, 20 Hz to 20 kHz bandpass filter | – | 1.3 | 3.0 | μV |
| Crosstalk rejection between channel 1 and channel 2 | CT | $R_g = 2.2 \text{ k}\Omega$, $V_O = -20 \text{ dBm}$, 1 kHz tuned filter | 45 | 56 | – | dB |
| Crosstalk rejection between forward and reverse tracks | | | 65 | 78 | – | |
| Supply voltage ripple rejection ratio | SVRR | $R_g = 2.2 \text{ k}\Omega$, $V_i = -30 \text{ dBm}$, $f_r = 100 \text{ Hz}$, 100 Hz tuned filter | 45 | 52 | – | dB |

Power amplifier with bass boost

$V_{CC} = 1.2 \text{ V}$, $T_a = 25 \text{ }^\circ\text{C}$, $f = 1 \text{ kHz}$, $0 \text{ dBm} = 0.775 \text{ V}$, $R_L = 10 \text{ k}\Omega$ (preamplifier), $R_L = 16 \text{ }\Omega$ (power amplifier)

| Parameter | Symbol | Condition | Rating | | | Unit |
|--------------------------|--------|---|--------|------|------|------|
| | | | min | typ | max | |
| Closed-loop voltage gain | VG_C | $V_O = -20 \text{ dBm}$ | 20.5 | 23.0 | 25.5 | dB |
| | | $V_O = -20 \text{ dBm}$, LBSW is ON. | 20.5 | 23.0 | 25.5 | |
| | | $V_O = -20 \text{ dBm}$, $f = 10 \text{ kHz}$, LBSW is ON. | 24.5 | 27.5 | 30.5 | |
| | | $V_O = -20 \text{ dBm}$, $f = 100 \text{ Hz}$, LBSW is ON. | 30 | 34 | 38 | |

LA4589W

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|-------------|---|--------|-----|-----|------------|
| | | | min | typ | max | |
| Output power | P_O | THD = 10% | 5 | 9 | – | mW |
| | | THD = 10%, $f = 100$ Hz, LBSW is ON. | 13 | 21 | – | |
| Total harmonic distortion | THD | $P_O = 1$ mW | – | 0.5 | 1.5 | % |
| Crosstalk rejection between left and right channels | CT | $V_O = -20$ dBm, $R_V = 0 \Omega$ | 38 | 43 | – | dB |
| Output noise voltage | V_{NO} | $R_V = 0 \Omega$, 20 Hz to 20 kHz bandpass filter | – | 35 | 48 | μ V |
| Supply voltage ripple rejection ratio | SVRR | $R_V = 0 \Omega$, $V_i = -30$ dBm, $f_r = 100$ Hz, 100 Hz tuned filter | 50 | 74 | – | dB |
| Input impedance | R_i | | 8 | 10 | 12 | k Ω |
| Voltage gain differential | ΔVG | | – | 0 | 1.5 | dB |

Ripple filter

$V_{CC} = 1.0$ V, $T_a = 25$ °C, $f = 1$ kHz, 0 dBm = 0.775 V, $R_L = 10$ k Ω (preamplifier), $R_L = 16 \Omega$ (power amplifier)

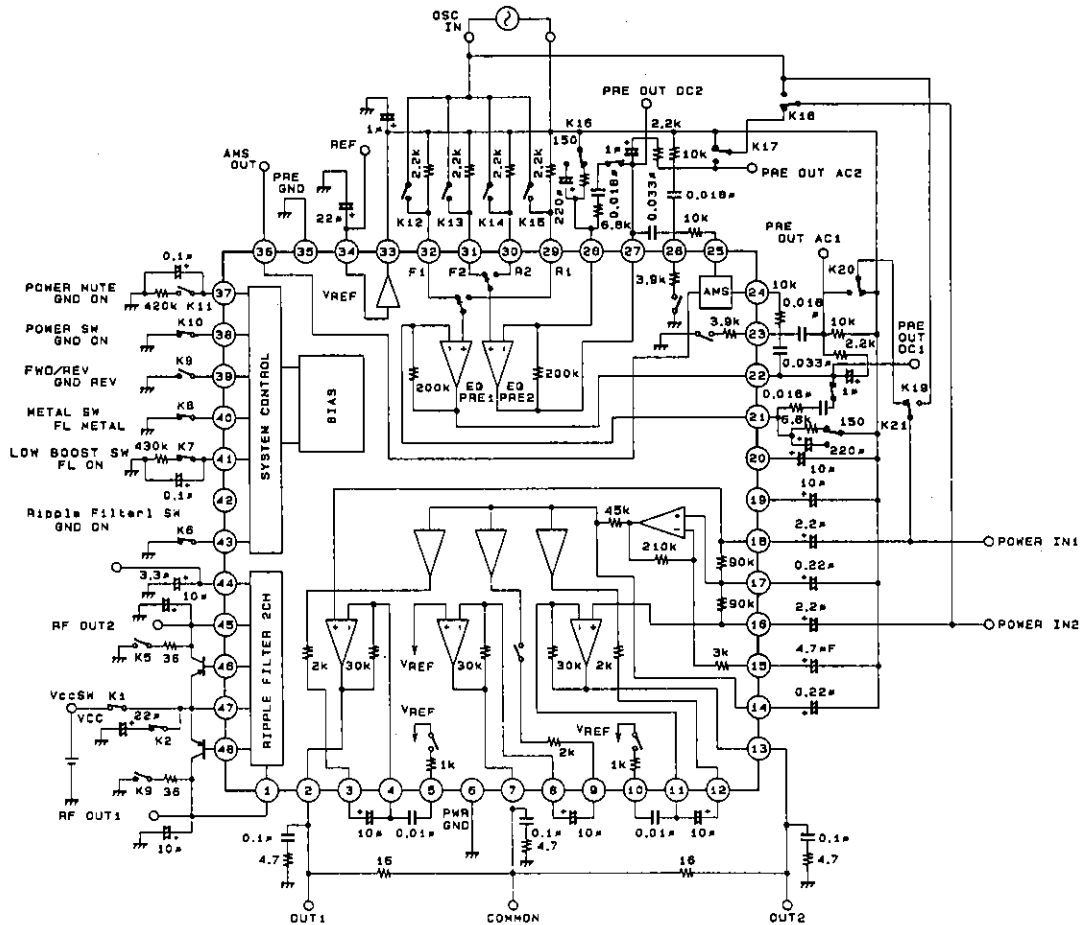
| Parameter | Symbol | Condition | Rating | | | Unit |
|---------------------------------------|----------|--|--------|------|-----|------|
| | | | min | typ | max | |
| Output voltage | V_{RF} | $I_{RF} = 25$ mA | 0.89 | 0.93 | – | V |
| Supply voltage ripple rejection ratio | SVRR | $f_r = 100$ Hz, $V_i = -30$ dBm, $I_{RF} = 25$ mA, output transistors with $h_{FE} \geq 6$ (2SB1295) | 33 | 39 | – | dB |

Automatic music search (AMS)

$V_{CC} = 1.2$ V, $T_a = 25$ °C, $f = 1$ kHz, 0 dBm = 0.775 V, $R_L = 10$ k Ω (preamplifier), $R_L = 16 \Omega$ (power amplifier)

| Parameter | Symbol | Condition | Rating | | | Unit |
|--------------------|------------|---------------------------------------|--------|-----|-----|------|
| | | | min | typ | max | |
| AMS output voltage | V_{OAMS} | $V_{PREOUT1} = V_{PREOUT2} =$ 6 mV | 470 | 570 | 670 | mV |

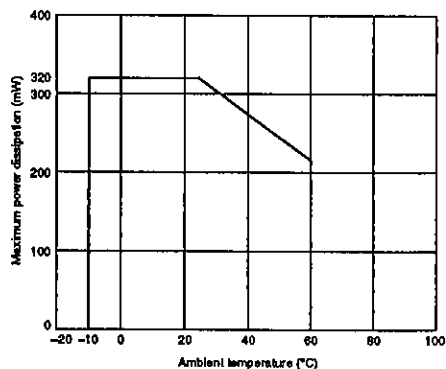
Measurement Circuit



Typical Performance Characteristics

Unit (resistance: Ω , capacitance: F)

Maximum power dissipation vs. ambient temperature



FUNCTIONAL DESCRIPTION

Preamplifier

The preamplifier incorporates equalization networks for normal- and metal-tape playback modes, and tape-direction switches for an auto-reverse cassette mechanism.

When METALSW is floating, metal-tape mode is selected. METAL1 and METAL2 are grounded internally through 3.9 k Ω resistors, adjusting the negative feedback network to provide metal-tape playback equalization.

When F/RSW is floating, forward playback mode is selected, and PREFI1 and PREFI2 are connected to the preamplifier inputs. When F/RSW is grounded, reverse playback mode is selected, and PRERI1 and PRERI2 are connected to the preamplifier inputs.

The automatic music search (AMS) circuit generates a signal that controls the cassette mechanism fast-forward and reverse functions in response to pauses between music tracks. The signal on AMSOUT is a pulse wave whose amplitude varies with the input signal levels on AMSIN1 and AMSIN2.

Power Amplifier

The power amplifier incorporates an additional amplifier to provide bass boost and mute functions.

When LBSW is floating, the bass boost function is selected. PHP1 and PHP2 are connected to VREF through 1 k Ω internal resistors, adjusting the negative feedback network to provide highpass filtering.

When PMUTESW is grounded, the power amplifier mute function is selected.

Ripple Filter

The ripple filters can be configured for either single or dual-filter operation. When RF1SW is grounded, the ripple filters are configured for dual-filter operation and RFOUT1 is active.

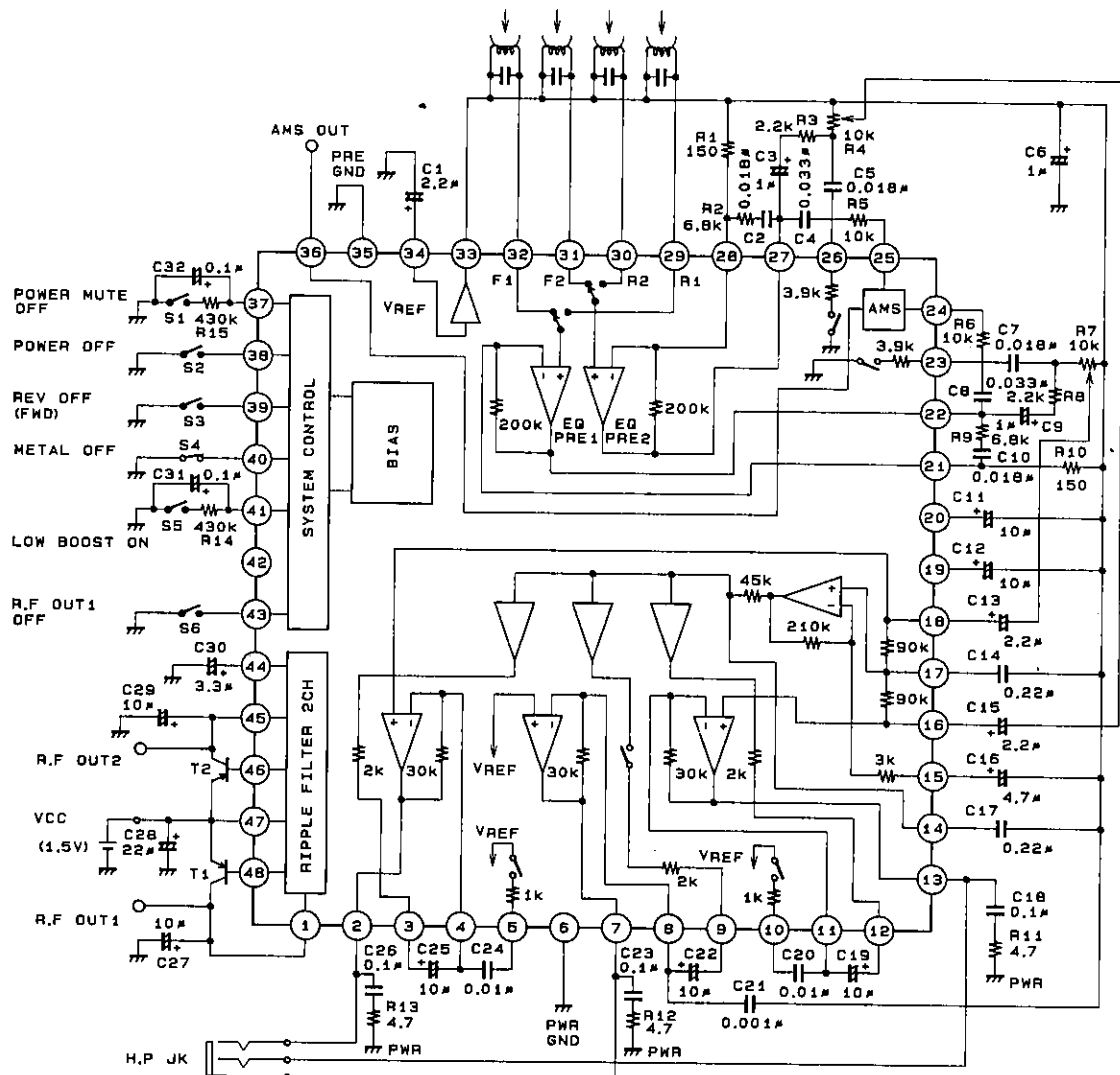
External Components Required

| Component | Recommended value | Description |
|---------------|-----------------------|---|
| C1 | 1.0 to 10 μ F | Reference voltage amplifier decoupling capacitor. Decreasing the capacitance reduces the supply voltage ripple rejection ratio. |
| C2, C10 | – | Preamplifier equalization RC network capacitors. |
| C3, C9 | 0.47 to 3.3 μ F | Preamplifier output capacitors |
| C4, C8 | – | AMS input highpass filter RC network capacitors |
| C5, C7 | – | Metal-tape equalization RC network capacitors |
| C6 | 0.1 to 22 μ F | Reference voltage decoupling capacitor. Reduces high-band noise. |
| C11, C12 | 3.3 to 10 μ F | NFC decoupling capacitors. Decreasing the capacitance reduces the preamplifier low-band gain. |
| C13, C15 | 1.0 to 3.3 μ F | Power amplifier input capacitors |
| C14, C17 | – | Low-boost lowpass filter and amplifier gain adjust capacitors |
| C16 | 1.0 to 4.7 μ F | Bass boost amplifier negative feedback capacitor. Decreasing the capacitance reduces the low-band gain. |
| C18, C23, C26 | 0.1 to 1.0 μ F | Power amplifier output oscillation-damping RC network capacitors |
| C19, C22, C25 | 3.3 to 10.0 μ F | Power amplifier negative feedback capacitors. Decreasing the capacitance reduces the low-band gain. |
| C20, C24 | – | Power amplifier highpass filter high-band gain adjust capacitors (bass-boost only) |
| C21 | 100 to 2200 pF | Smoothing capacitor |
| C27, C29 | 4.7 to 10 μ F | Ripple filter output decoupling capacitors |
| C28 | 22 to 220 μ F | Power supply capacitor |
| C30 | 2.2 to 10.0 μ F | Ripple filter capacitor |
| C31, C32 | 0.047 to 0.22 μ F | Switching noise filter capacitors |
| R1, R10 | – | Preamplifier gain adjust resistors |

LA4589W

| Component | Recommended value | Description |
|---------------|------------------------|--|
| R2, R9 | | Preamplifier equalization RC network resistors |
| R3, R8 | | Metal-tape preamplifier equalization RC network resistors |
| R4, R7 | 10 k Ω variable | Volume control resistors |
| R5, R6 | - | Automatic music search (AMS) highpass filter and gain adjust resistors |
| R11, R12, R13 | - | Power amplifier output oscillation-damping RC network resistors |
| R14, R15 | 100 to 430 k Ω | Switching noise filter resistors |

TYPICAL APPLICATION



Unit (resistance: Ω , capacitance: F)

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