

SANYO**LA4589W****1.5V Stereo Headphone Preamplifier
and Power Amplifier****Overview**

The LA4589W is a 1.5V 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 μF) 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 2.2V supply and is available in 48-pin SQFPs.

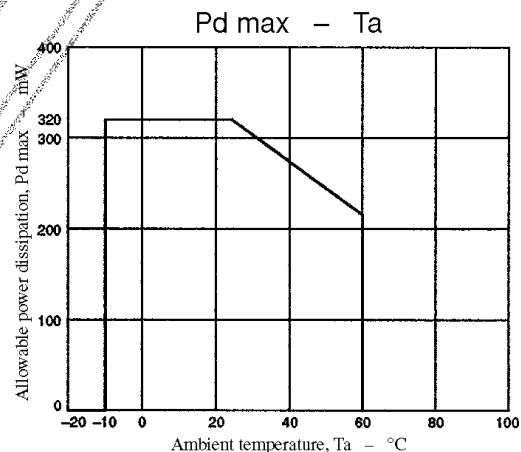
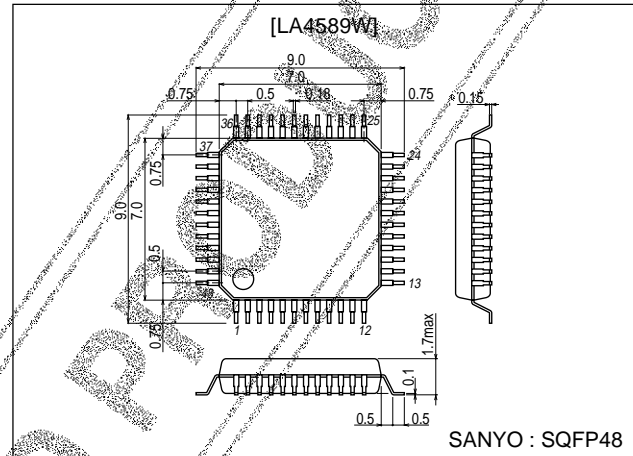
Features

- 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.
- 73dB (typ) preamplifier open-loop voltage gain.
- 21mW (typ) output power with bass boost.
- Built-in noise reduction capacitors.
- 0.95 to 2.2V supply.
- 48-pin SQFP.

Package Dimensions

unit:mm

3163A-SQFP48



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Specifications

Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC\text{ max}}$		3.0	V
Allowable power dissipation	$P_d\text{ max}$		320	mW
Operating temperature	T_{opr}		-10 to +60	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +125	$^\circ\text{C}$

Operating Conditions at $T_a = 25^\circ\text{C}$

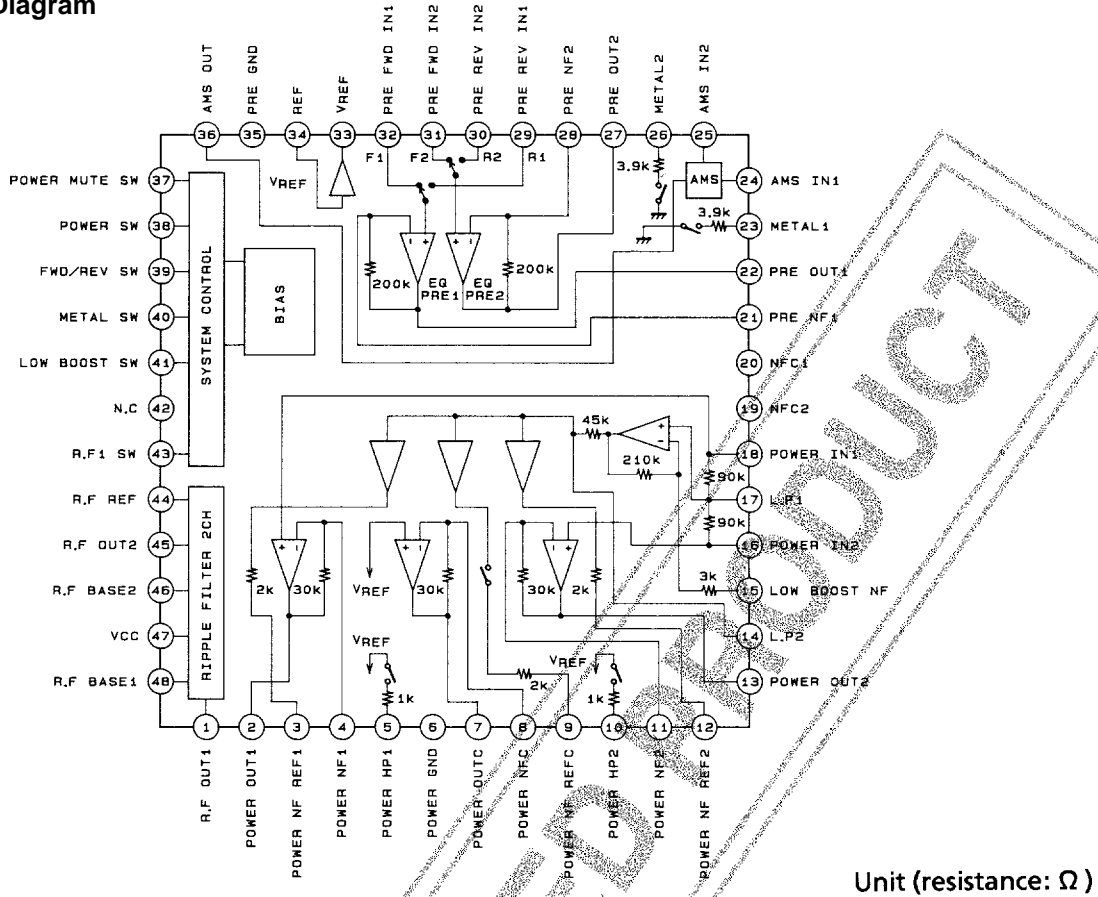
Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		1.5	V
Operating voltage	$V_{CC\text{ op}}$		0.95 to 2.2	V

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

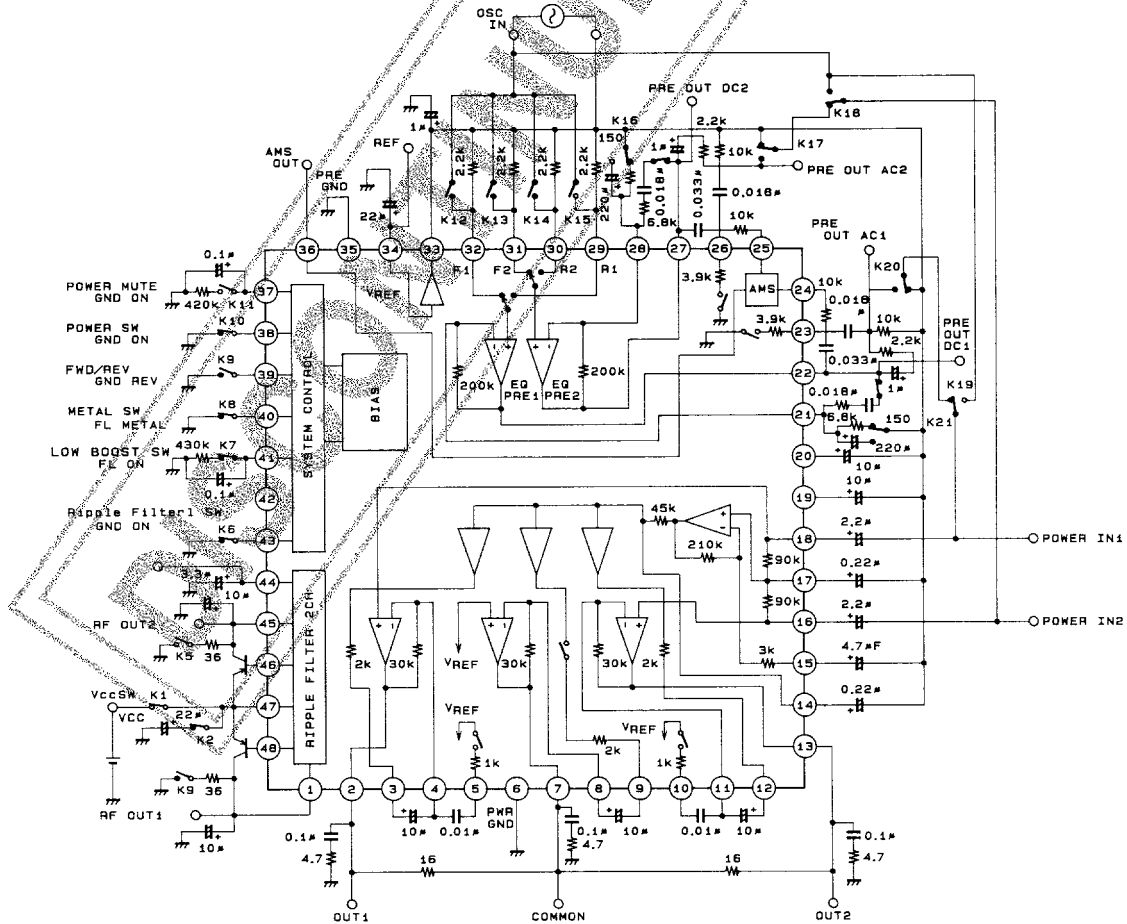
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Preamplifier and power amplifier]						
Quiescent current	I_{CCO1}	$R_g=2.2\text{k}\Omega$, $R_v=0\Omega$	8	15	24	mA
	I_{CCO2}	PSW is OFF.		0.1	5.0	μA
Closed-loop voltage gain	V_{GT}	$V_O=-20\text{dBm}$, $R_v=10\text{k}\Omega$	54	57	60	dB
[Preamplifier]						
Open-loop voltage gain	V_{GO}	$V_O=-20\text{dBm}$	60	73		dB
Closed-loop voltage gain	V_{G1}	$V_O=-20\text{dBm}$	34.0	35.5	37.0	dB
	V_{G2}	$V_O=-20\text{dBm}$, $f=10\text{kHz}$, METALSW is ON.	25.5	28.0	30.5	dB
Maximum output voltage	$V_O\text{ max}$	THD=1%	100	210		mV
Total harmonic distortion	THD ₁	$V_G=35.5\text{dB/NAB}$, $V_O=100\text{mV}$		0.1	0.5	%
Equivalent input noise voltage	V_{NI}	$R_g=2.2\text{k}\Omega$, 20Hz to 20kHz bandpass filter		1.3	3.0	μV
Crosstalk rejection between channel 1 and channel 2	CT1	$R_g=2.2\text{k}\Omega$, $V_O=-20\text{dBm}$, 1kHz tuned filter	45	56		dB
Crosstalk rejectin between forward and reverse tracks	CT2	$R_g=2.2\text{k}\Omega$, $V_O=-20\text{dBm}$, $f_r=100\text{Hz}$, 100Hz tuned filter	65	78		dB
Ripple rejection ratio	Rr1	$R_g=2.2\text{k}\Omega$, $V_O=-30\text{dBm}$, $f_r=100\text{Hz}$, 100Hz tuned filter	45	52		dB
[Power amplifier with bass boost]						
Closed-loop voltage gain	V_{G3}	$V_O=-20\text{dBm}$	20.5	23.0	25.5	dB
	V_{G4}	$V_O=-20\text{dBm}$, LBSW is ON.	20.5	23.0	25.5	dB
	V_{G5}	$V_O=-20\text{dBm}$, $f=10\text{kHz}$, LBSW is ON.	24.5	27.5	30.5	dB
	V_{G6}	$V_O=-20\text{dBm}$, $f=100\text{Hz}$, LBSW is ON.	30	34	38	dB
Output power	P_{O1}	THD=10%	5	9		mW
	P_{O2}	THD=10%, $f=100\text{Hz}$, LBSW is ON.	13	21		mW
Total harmonic distortion	THD2	$P_O=1\text{mW}$		0.5	1.5	%
Crosstalk rejection between left and right channels	CT3	$V_O=-20\text{dBm}$, $R_v=0\Omega$	38	43		dB
Output noise voltage	V_{NO}	$R_v=0\Omega$, 20Hz to 20kHz bandpass filter		35	48	μV
Ripple rejection ratio	Rr2	$R_v=0\Omega$, $V_r=-30\text{dBm}$, $f_r=100\text{Hz}$, 100Hz tuned filter	50	74		dB
Input impedance	R_I		8	10	12	$\text{k}\Omega$
Voltage gain differential	ΔV_{G3}			0	1.5	dB
[Ripple filter]						
Output voltage	V_{RF}	$I_{RF}=25\text{mA}$, $V_{CC}=1.0\text{V}$	0.89	0.93		V
Ripple rejection ratio	Rr3	$f_r=100\text{Hz}$, $V_r=-30\text{dBm}$, $V_{CC}=1.0\text{V}$, $I_{RF}=25\text{mA}$, output transistors with $h_{FE} \geq 6$ (2SB1295)	33	39		dB
[Automatic music search (AMS)]						
AMS output voltage	V_{OAMS}	$V_{PREOUT1}=6\text{mV}$	470	570	670	mV

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Block Diagram

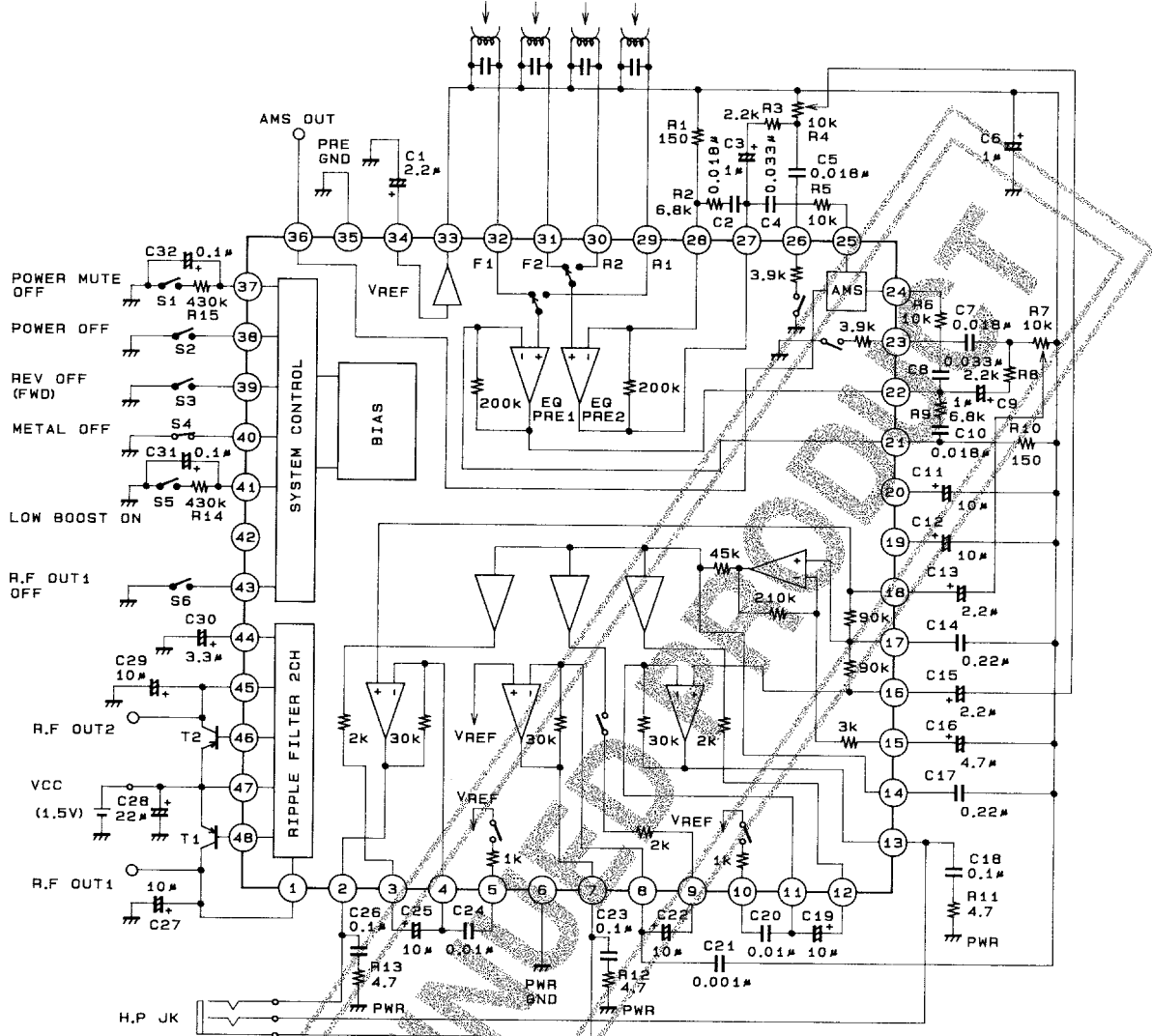


Test Circuit



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Sample Application Circuit



Unit (resistance: Ω , capacitance: F)

Note : Use the 2SB1295 of hFE rank 6 or higher.

Pin Description

Number	Name	Equivalent circuit	Description
1	RFOUT1		Ripple filter outputs. Nominal voltage is 1.13V
45	RFOUT2		Ripple filter outputs. Nominal voltage is 1.13V
2	POUT1		Power amplifier output 1. Nominal voltage is 0.6V.
7	POUTC		Power amplifier common output. Nominal voltage is 0.6V.
13	POUT2		Power amplifier output 2. Nominal voltage is 0.6V.

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Number	Name	Equivalent circuit	Description
3	PNFREF1		Power amplifier output 1 negative feedback reference voltage. Nominal voltage is 0.75V.
9	PNFREFC		Power amplifier common output negative feedback reference voltage. Nominal voltage is 0.75V.
12	PNFREF2		Power amplifier output 2 negative feedback reference voltage. Nominal voltage is 0.75V.
4	PNF1		Power amplifier output 1 negative feedback network connection. Nominal voltage is 0.75V.
8	PNFC		Power amplifier common output negative feedback network connection. Nominal voltage is 0.75V.
11	PNF2		Power amplifier output 2 negative feedback network connection. Nominal voltage is 0.75V.
5	PHP1		Power amplifier highpass filter outputs for bass boost. Nominal voltage is 0.75V.
10	PHP2		
6	PGND		Power amplifier ground.
14	LP2		Bass boost amplifier lowpass filter capacitor connection 2. Nominal voltage is 0.75V.
15	LBNF		Bass boost amplifier negative feedback capacitor connection. Nominal voltage is 0.75V.
16	PIN2		Power amplifier inputs. Nominal voltage is 0.75V.
18	PIN1		

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Number	Name	Equivalent circuit	Description
17	LP1		Bass boost amplifier lowpass filter capacitor connection.1. Nominal voltage is 0.75V.
19	NFC2		Negative feedback capacitor connections. Nominal voltage is 0.75V.
20	NFC1		
21	PRENF1		Preamplifier channel 1 negative feedback network connection. Nominal voltage is 0.75V.
28	PRENF2		Preamplifier channel 2 negative feedback network connection. Nominal voltage is 0.75V.
22	PREOUT1		Preamplifier outputs. Nominal voltage is 0.45V.
27	PREOUT2		
23	METAL1		Preamplifier channel 1 metal-tape mode connection. Nominal voltage is 0V.
26	METAL2		Preamplifier channel 2 metal-tape mode connection. Nominal voltage is 0V.
24	AMSIN1		Automatic music search inputs. Nominal voltage is 0.75V.
25	AMSIN2		
29	PRER11		Preamplifier reverse playback inputs. Nominal voltage is 0.75V.
30	PRER12		

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Number	Name	Equivalent circuit	Description
31	PREFI2		Preamplifier forward playback inputs. Nominal voltage is 0.75V.
32	PREFI1		
33	VREF		Reference voltage amplifier output. Nominal voltage is 0.75V.
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.

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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 1.13V.
46	RFBASE2		Ripple filter external pnp-transistor 2 base connection. Nominal voltage is 0.5V.
48	RFBASE1		Ripple filter external pnp-transistor 1 base connection. Nominal voltage is 0.5V.
47	V _{CC}		Supply voltage.

Note

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

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 3.9kΩ 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 1kΩ 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 2200pF	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.
R2, R9	–	Preamplifier equalization RC network resistors.
R3, R8	–	Metal-tape preamplifier equalization RC network resistors.
R4, R7	10k 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 430k Ω	Switching noise filter resistors.

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