

# AN7504SB

Pre-amp. and power amp. IC for 1.5 V headphone stereo

## ■ Overview

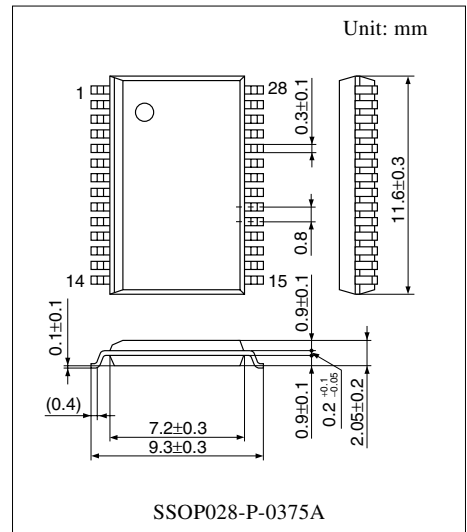
The AN7504SB is a low voltage operation headphone amp. IC for headphone C-cassette stereo. It incorporates tape selector, pre-amp. , soft AGC bass-boost circuit, etc.

## ■ Features

- Low voltage operation (0.98 V to 2.0 V)
- Tape selector switch built-in
- Low frequency boost function with soft AGC

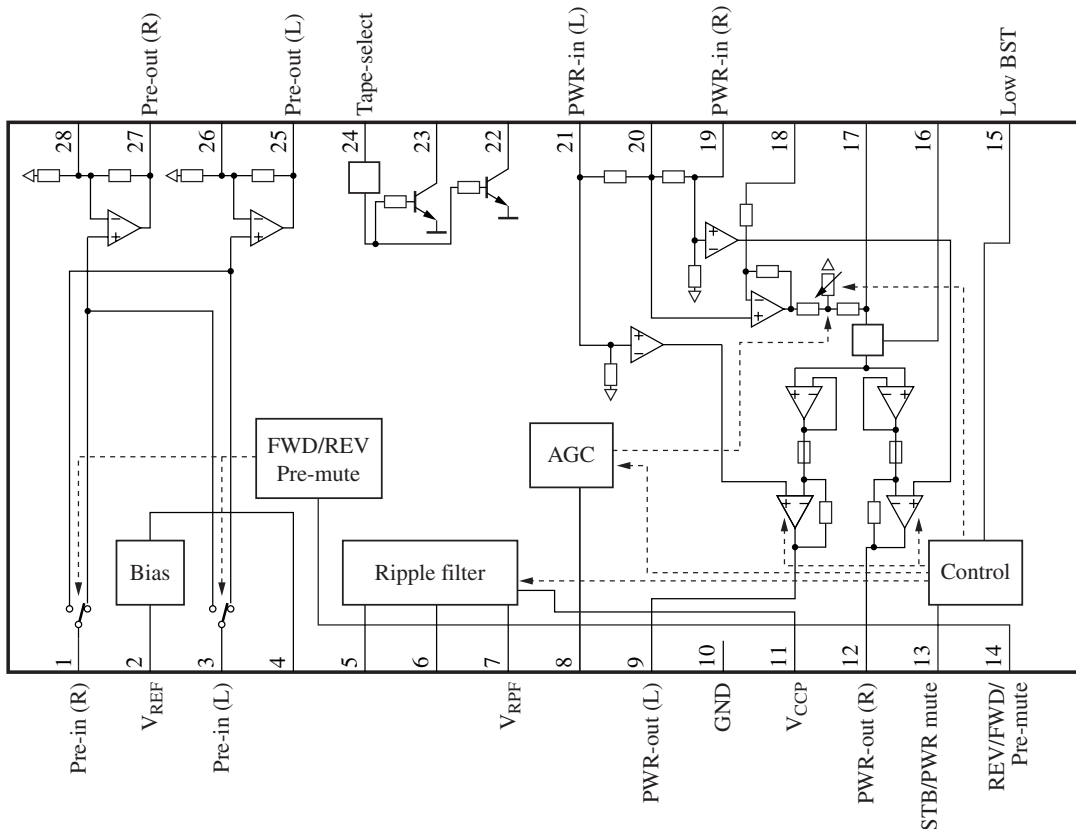
## ■ Applications

- Headphone stereo



Note) The package of this product will be changed to lead-free type (SSOP028-P-0375E). See the new package dimensions section later of this datasheet.

## ■ Block Diagram



### ■ Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	2.1	V
Supply current	$I_{CC}$	20	mA
Power dissipation *2	$P_D$	42	mW
Operating ambient temperature *1	$T_{opr}$	-20 to +70	°C
Storage temperature *1	$T_{stg}$	-55 to +125	°C

Note) \*1: Except for the operating ambient temperature and storage temperature, all ratings are for  $T_a = 25^\circ\text{C}$ .

Keep  $V_{CC}$  (0.95 V to 0.98 V) free from any abnormal operation such as oscillation.

\*2: The power dissipation shown is the value for  $T_a = 75^\circ\text{C}$ . For the independent IC without a heat sink.

### ■ Recommended Operating Range

Parameter	Symbol	Range	Unit
Supply voltage	$V_{CC}$	0.98 to typ. 1.2 to 2.0	V

### ■ Electrical Characteristics at $V_{CC} = 1.2\text{ V}$ , $f = 1\text{ kHz}$ , $R_L = 32\ \Omega$ , $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Voltage gain	$G_V$	$V_O = -22.2\text{ dBV}$	54	57	60	dB
Circuit current 1	$I_{CC1}$	$V_{IN} = 0$ , $R_G = 2.2\text{ k}\Omega$ , LBST off	—	2.2	5.3	mA
<b>Pre-amp. block</b>						
Closed circuit voltage gain	$G_{VC(PB)}$	$V_O = -22.2\text{ dBV}$	32.5	34	35.5	dB
Max. output voltage	$V_{Omax(PB)}$	THD = 1%, 30 kHz LPF on	120	210	—	mV
Total harmonic distortion	THD <sub>(PB)</sub>	$V_O = 22.2\text{ dBV}$ , 30 kHz LPF on $G_{VC} = 35\text{ dB}$ (NAB)	—	0.2	0.6	%
Output noise voltage	$V_{NO(PB)}$	$R_G = 2.2\text{ k}\Omega$ , 1HF-A	—	-90	-76	dBV
Mute attenuation	$G_{MUTE(PB)}$	Ratio as $V_O = -22.2\text{ dBV}$ Pre-mute on	—	-85	-70	dB
<b>Boost low sound and power amp. block</b>						
Voltage gain 1	$G_{V1(PW)}$	$V_O = -22.2\text{ dBV}$	21	23	25	dB
Voltage gain 2	$G_{V2(PW)}$	LBOOST on, $V_O = -22.2\text{ dBV}$	21.4	23.4	25.4	dB
Rating output power	$P_{OUT}$	THD = 10%, 30 kHz LPF on	2.5	4.5	—	mW
Total harmonic distortion	THD <sub>(PW)</sub>	$P_{OUT} = 1\text{ mW}$ , 30 kHz LPF on	—	0.35	1.3	%
Output noise voltage 1	$V_{NO1(PW)}$	$R_G = 0.1$ , 1HF-A	—	-91	-86	dBV
Output noise voltage 2	$V_{NO2(PW)}$	LBOOST on, $R_G = 0$ , 1HF-A	—	-86	-82	dBV
Channel balance	CB <sub>(PW)</sub>	$V_O = -22.2\text{ dBV}$	-1.5	0	1.5	dB
Mute output voltage	$V_{MUTE(PW)}$	$V_{IN} = -32.2\text{ dBV}$	—	-96	-90	dBV
AGC level	$V_{AGC}$	$V_{IN} = -45.2\text{ dBV}$ , $f = 100\text{ Hz}$ $R_L = 32\ \Omega$ AGC level: 32 $\Omega$ edge measure	-17.3	-14.7	-13.1	dBV

**■ Electrical Characteristics at  $V_{CC} = 1.2\text{ V}$ ,  $f = 1\text{ kHz}$ ,  $R_L = 32\ \Omega$ ,  $T_a = 25^\circ\text{C}$  (continued)**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>Ripple filter block</b>						
Ripple rejection ratio	RR	$V_{CC} = 1.1\text{ V}$ , $V_{RR} = -32.2\text{ dBV}$ $f_{RR} = 100\text{ Hz}$ , $I_{RFO} = 15\text{ mA}$ BPF: 100 Hz, 1/4 OCT	24	30	—	dB
DC output voltage	$V_{RPF}$	$V_{CC} = 1.0\text{ V}$ , $I_{RFO} = 15\text{ mA}$	0.89	0.94	—	V
<b>Bias block</b>						
DC output voltage	$V_{REF}$	$V_{CC} = 1.0\text{ V}$	0.68	0.76	0.83	V
<b>Control block</b>						
Threshold voltage at standby on	$V_{STON}$	Low: Power off	—	—	0.1	V
Threshold voltage at standby off	$V_{STOFF}$	Open: Power on (Power mute on) $V_{STOFF} = 1/2V_{CC} - V_{13}$	-0.2	—	0.2	V
Bias voltage at power mute off	$V_{MTOFF}$	Open: Power mute off $V_{MTOFF} = V_{CC} - V_{13}$	—	—	0.1	V
Low threshold at FWD/REV/pre-mute	$V_{THIL}$	Low: REV	—	—	0.1	V
High threshold at FWD/REV/pre-mute	$V_{THIH}$	High: Pre-mute on $V_{THIH} = V_{CC} - V_1$	—	—	0.1	V
Low threshold at low boost off	$V_{LBOFF}$	Low: LBOOST off	—	—	0.3	V
Low threshold at tape select off	$V_{TPOFF}$	Low: Tape-select off	—	—	0.3	V

**• Design reference data**

Note) The characteristics listed below are theoretical values based on the IC design and are not guaranteed.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Circuit current 2	$I_{CC2}$	$P_{OUT} = 0.5\text{ mW}$ , $\times 2\text{-ch.}$ , $R_L = 32\ \Omega$	—	6.5	11.2	mA
<b>Boost low sound and power amp. block</b>						
Input resistance	$R_{IN(PW)}$	—	7.2	9.5	12	k $\Omega$

■ Terminal Equivalent Circuits

Note) The values mentioned below are the typical ones and is subject to change due to application condition and dispersion of IC.

Pin No.	Equivalent circuit	Description	Waveform (typ.)
1		PB-in (R): Playback amp. input	 DC 0.78 V AC -66.2 dBV
2		V <sub>REF</sub> : Reference voltage output	DC 0.78 V
3	Refer to pin 1	PB-in (L): Playback amp. input	Refer to pin 1
4	Refer to pin 2	V <sub>REF</sub> -in: Reference voltage input	DC 0.78 V
5		RF-in: Ripple filter reference voltage input	DC 1.0 V
6		RF-base: Ripple filter	DC 0.47 V
7		V <sub>RPF</sub> : Ripple filter reference voltage output	DC 1.13 V

■ Terminal Equivalent Circuits (continued)

Note) The values mentioned below are the typical ones and is subject to change due to application condition and dispersion of IC.

Pin No.	Equivalent circuit	Description	Waveform (typ.)
8		AGC-TAU: AGC time constant	—
9		PWR-out (L): Power amp. voltage output	 DC 0.6 V AC -8.8 dBV
10	—	GND: GND pin	0 V
11	—	V <sub>CC</sub> : Power supply pin	1.2 V
12	Refer to pin 9	PWR-out (R): Power amp. voltage output	Refer to pin 9
13		STBY, PWR mute CNT: PWR-mute off Pin open: $V_{CC} - V_{13} < 0.1 V$ PWR-mute on $-0.2 V < 1/2V_{CC} - V_{13} < 0.2 V$ STBY on $V_{13} < 0.1 V$	—
14		FWD/REV/Pre-mute: FWD/REV/pre-mute control Pre-mute Voltage high: $V_{CC} - 0.1 < V_{14-19}$ FWD Pin open REV Voltage low: $V_{14-19} < 0.1$	—

■ Terminal Equivalent Circuits (continued)

Note) The values mentioned below are the typical ones and is subject to change due to application condition and dispersion of IC.

Pin No.	Equivalent circuit	Description	Waveform (typ.)
15		<p>L-BST CNT: Low boost on/off control</p> <p>L-BST on Pin open L-BST off Voltage low: <math>-0.3\text{ V} &lt; V_{11-19} &lt; 0.3\text{ V}</math></p>	DC 0 V
16		<p>L-BST C: Low boost Capacitor pin</p>	<p>DC 0.78 V</p>
17		<p>LPF2-C: LPF2 Capacitor pin</p>	<p>DC 0.78 V</p>
18		<p>L-BST C1: Low boost Capacitor pin</p>	<p>DC 0.78 V</p>

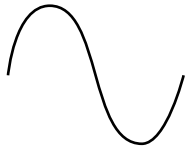
■ Terminal Equivalent Circuits (continued)

Note) The values mentioned below are the typical ones and is subject to change due to application condition and dispersion of IC.

Pin No.	Equivalent circuit	Description	Waveform (typ.)
19		PWR-in (R): Power amp. input	 DC 0.78 V AC -32.2 dBV
20		LPF1-C: LPF C pin	DC 0.78 V
21		PWR-in (L): Power amp. input	Refer to pin 19
22		Tape-select on/off: Tape select driver	—
23		Tape-select on/off: Tape select driver	—
24		Tape-select on/off CNT: Tape select driver  Driver on Voltage high Driver off $V_{24} < 0.3$ V	—
25	Refer to pin 1	PB-out (L): Playback amp. output	 DC 0.6 V AC -32.2 dBV

### ■ Terminal Equivalent Circuits (continued)

Note) The values mentioned below are the typical ones and is subject to change due to application condition and dispersion of IC.

Pin No.	Equivalent circuit	Description	Waveform (typ.)
26	Refer to pin 1	PB-NF(L): Playback amp. negative feedback input	 DC 0.78 V
27	Refer to pin 1	PB-OUT(R): Playback amp. input	Refer to pin 25
28	Refer to pin 1	PB-NF(R): Playback amp. negative feedback input	Refer to pin 26

### ■ Application Notes

#### 1. Operation logic of control pin

Pin 24	Low	High or Open
Tape select control	Off (Pins 22, 23 High)	On (Pins 22, 23 Low)

Pin 14	Low	Open	High
Pre-amp. system control	Reverse	Forward	Mute
	Input pin → Output pin	Input pin → Output pin	
	Pin 1 → Pin 25	Pin 1 → Pin 27	
	Pin 3 → Pin 27	Pin 3 → Pin 25	

Pin 13	Low 1	Low 2	High
Power amp. system control	Standby on	Standby off, Mute on	Mute on

Low 1: Short-circuit to GND

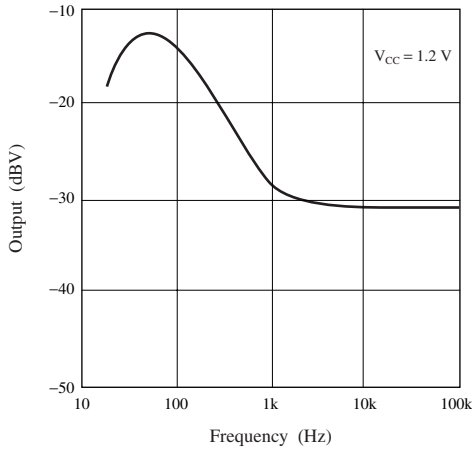
Low 2: 0.6 V application or short circuit to GND with 220 kΩ



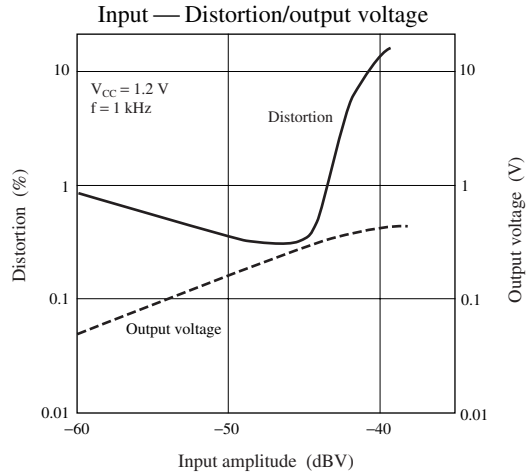
Application Notes (continued)

2. Main characteristics

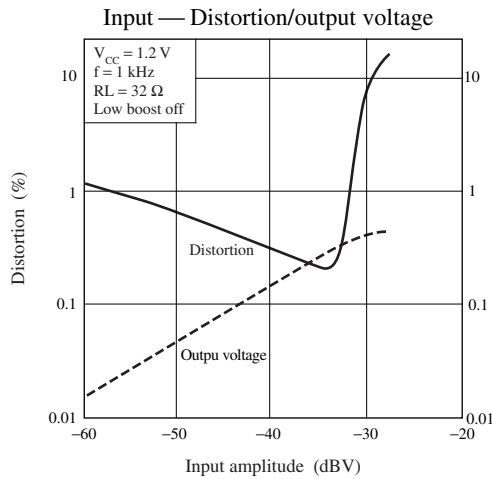
1. Pre-amp. output frequency characteristics



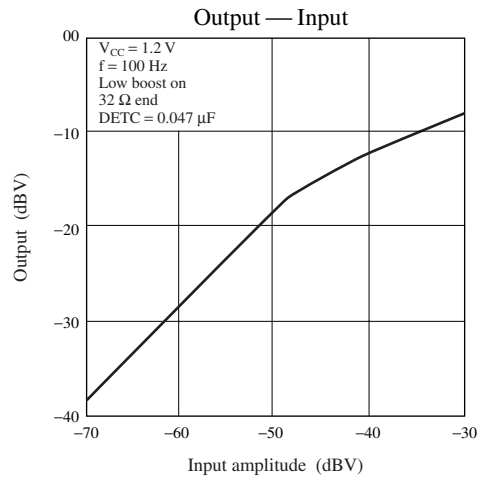
2. Distortion and amplitude at pre-amp. output



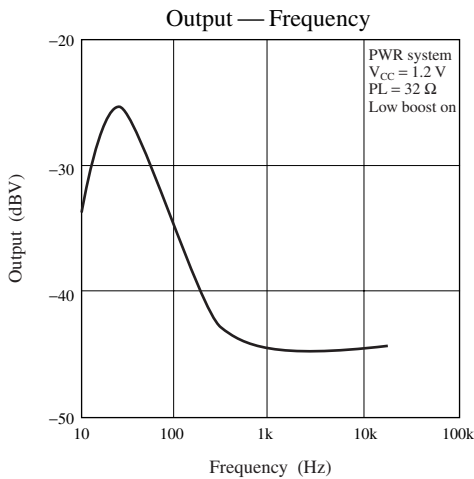
3. Distortion and amplitude characteristics of headphone amp.



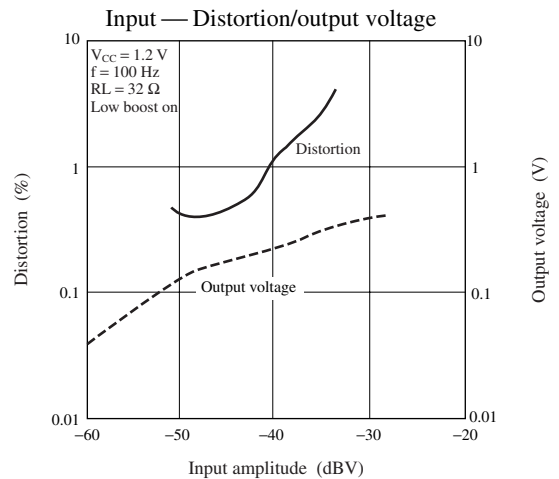
4. Headphone amp.



5. Headphone amp.



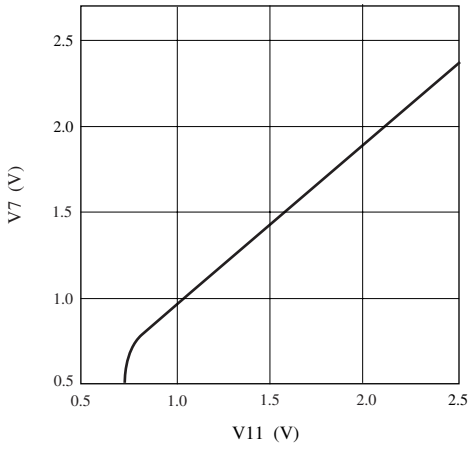
6. Distortion and amplitude at headphone amp. output



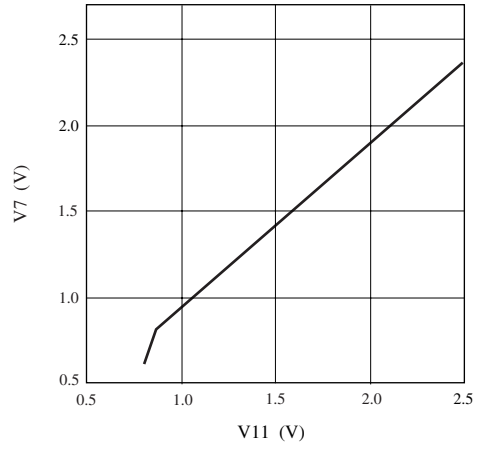
■ Application Notes (continued)

2. Main characteristics (continued)

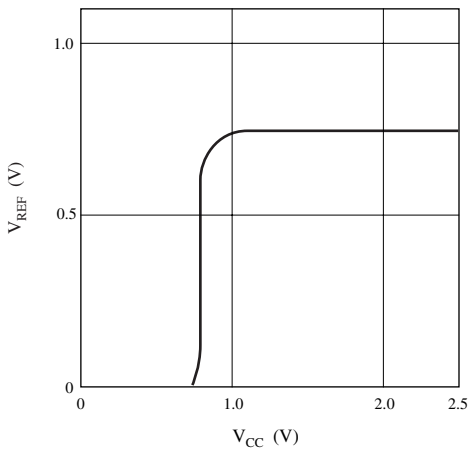
7. Ripple filter output voltage (pin 7)



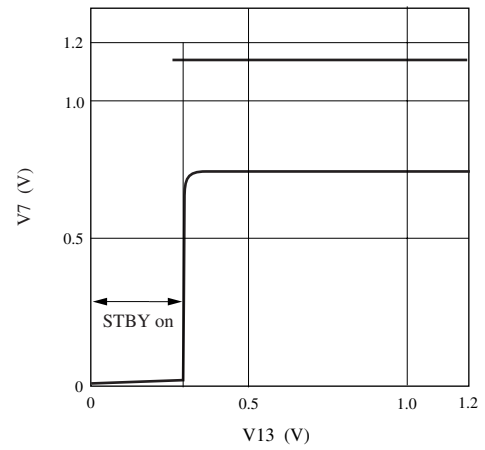
8. Ripple filter output voltage (Using at 15 mA of current)



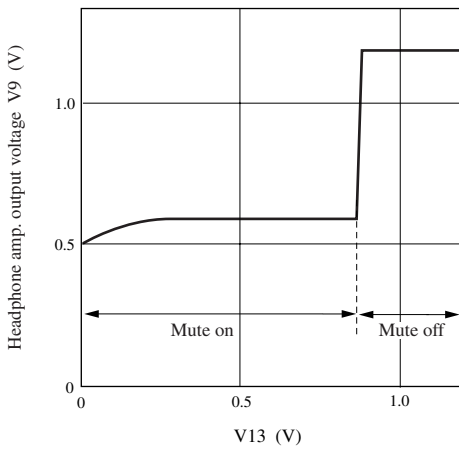
9.  $V_{CC} - V_{REF}$



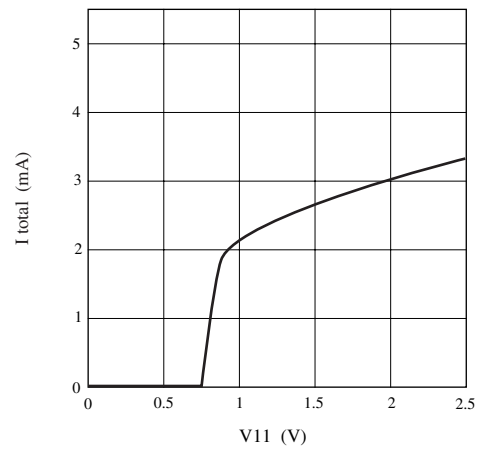
10. Pin 2 ( $V_{REF}$ ) at standby on/off and voltage at pin 7 (Ripple filter)



11. Headphone amp. at mute on/off (Pin 9) output voltage

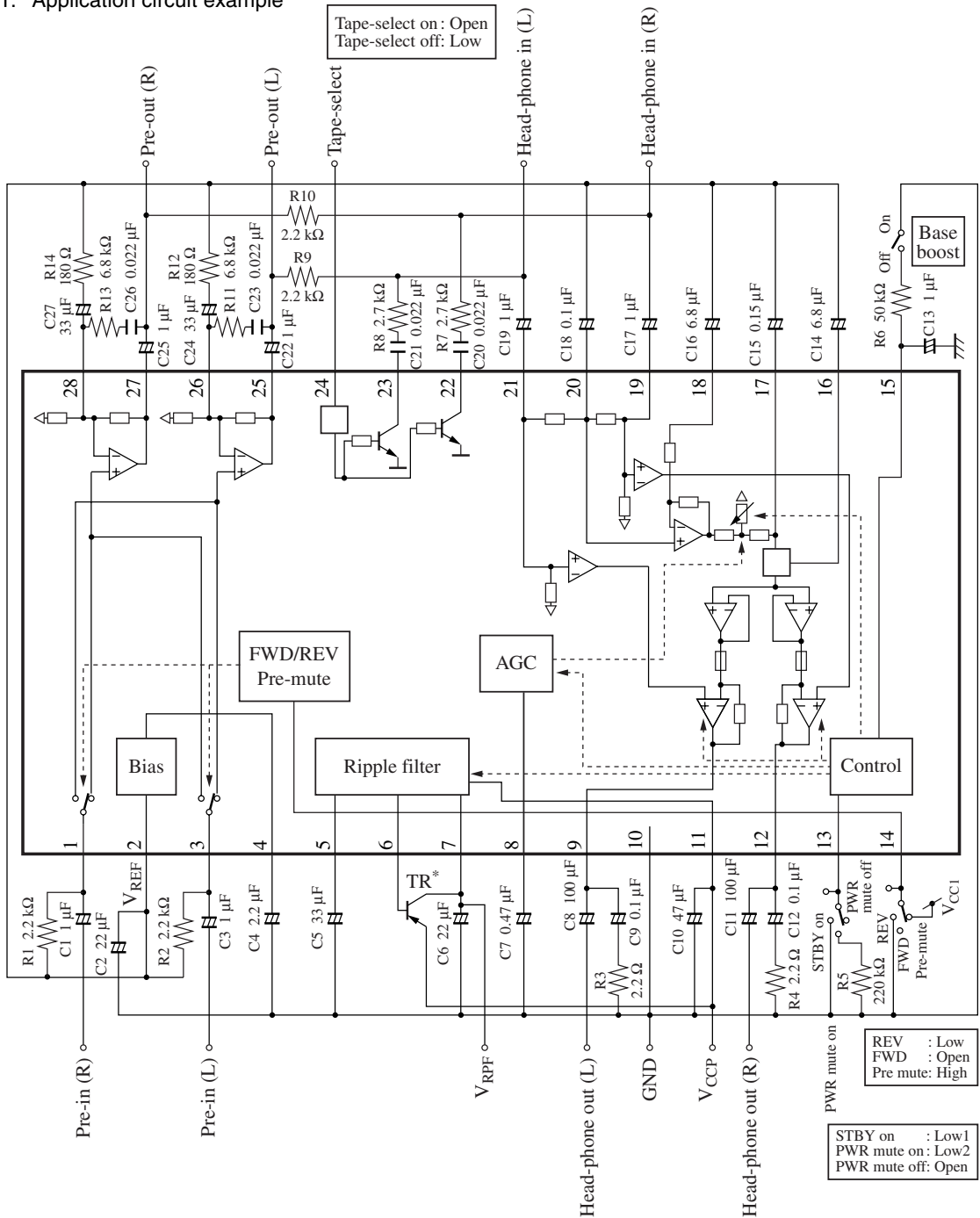


12.  $V_{CC} - I_{total}$



Application Circuit Examples

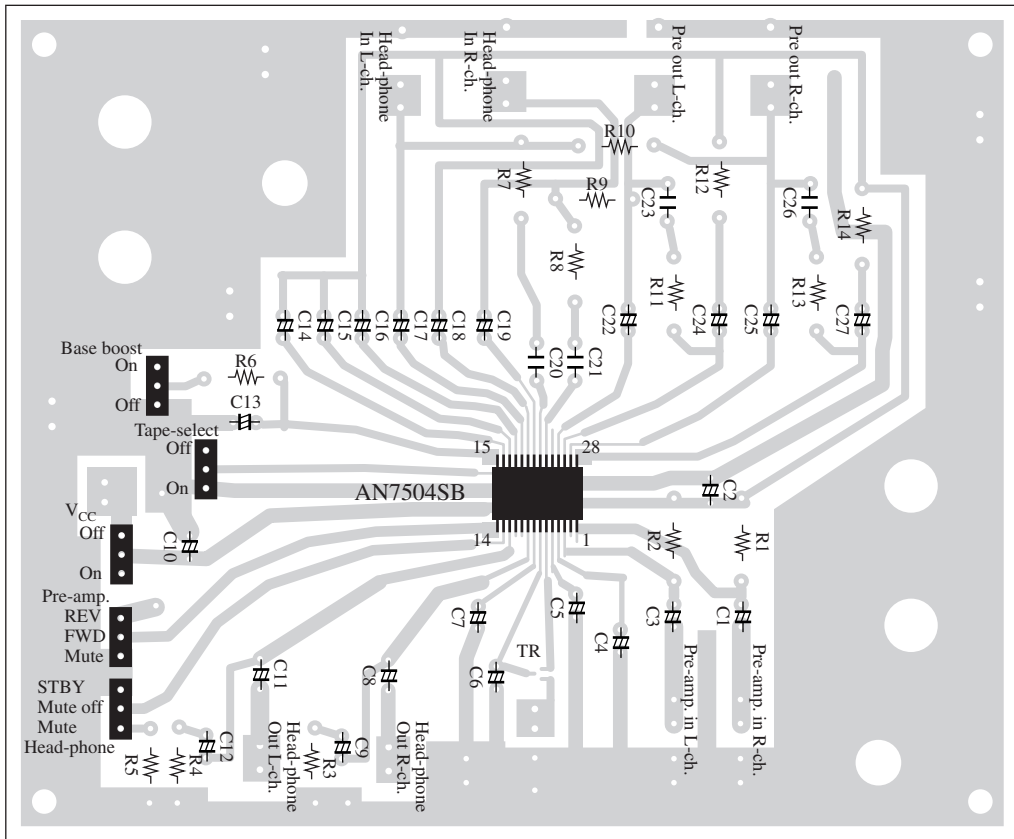
1. Application circuit example



Note) \*: The low  $V_{CE(SAT)}$  PNP TR be used as TR.

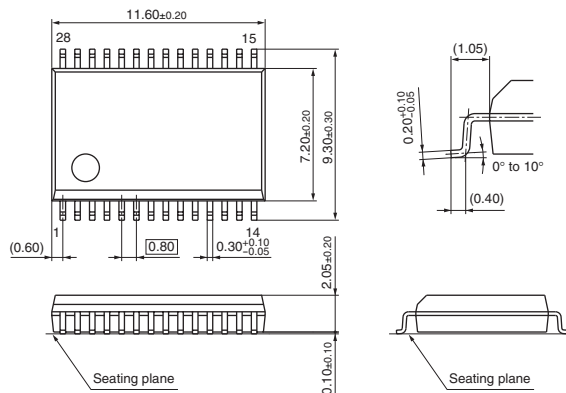
■ Application Circuit Examples (continued)

2. Evaluation board



■ New Package Dimensions (Unit: mm)

- SSOP028-P-0375E (Lead-free package)



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