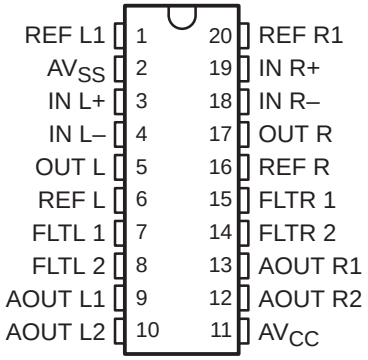
SLAS123B – MARCH 1995 – REVISED NOVEMBER 1995

- **Analog Front-End Integrated Circuit for the 18-Bit Stereo Audio Sigma-Delta Analog-to-Digital Converter TLC320AD58C**
- **Low Distortion, Low Noise**
  - **THD+N . . . 0.00056% Typ**
  - **SNR . . . 108-dB Typ**
- **Adjustable Signal Gain**
- **5-V Single Supply Operation**
- **Internal Voltage Reference**
- **Operating Temperature . . . 0°C to 70°C**

NS PACKAGE
(TOP VIEW)



AVAILABLE OPTIONS

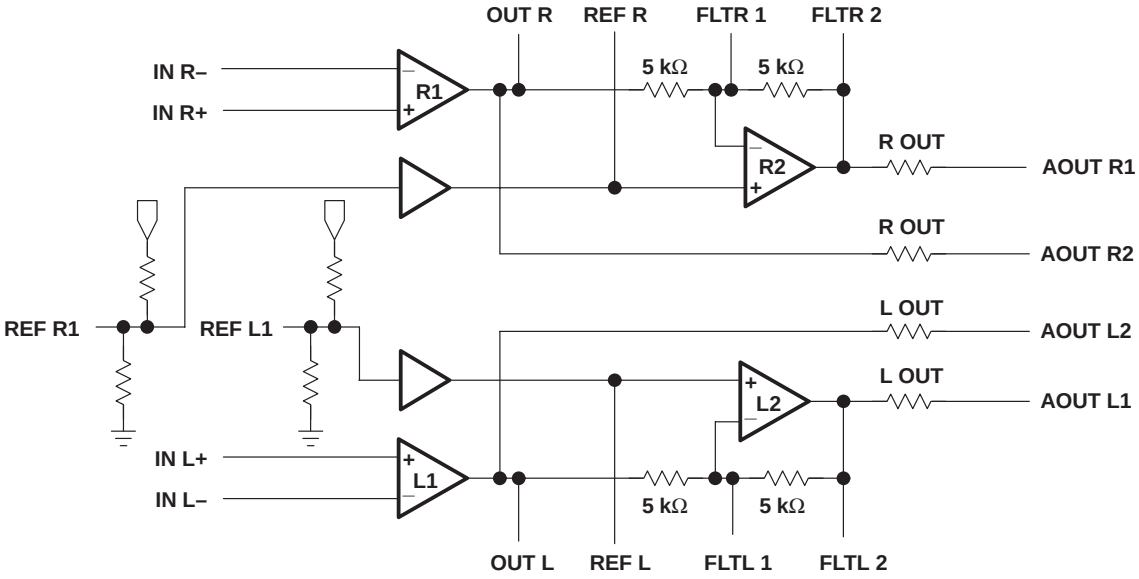
T_A	PACKAGE
	SMALL OUTLINE (NS)
0°C to 70°C	TL32088CNS

description

The TL32088 is an analog signal conditioning integrated circuit built using a proprietary Texas Instruments bipolar process. This device is used for the analog signal input stage for the 18-bit, stereo audio, sigma-delta, analog-to-digital converter (ADC) TLC320AD58C exclusively. The TL32088 can convert input signals from single-ended to differential and differential to single-ended. The TL32088 also implements a single-ended to single-ended and differential to differential amplifier buffer. The differential output can be connected to the TLC320AD58C directly. The TLC32088 is composed of high performance amplifiers that offer wide output swing with low distortion and low noise. The reference voltage for the internal amplifier circuit is provided from an internal voltage reference circuit.

The TL32088 provides a wide output swing while maintaining 0.00056% THD+N and 108-dB SNR and, therefore, is ideally suited for high-end audio systems.

functional block diagram



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absolute maximum rating over operating free-air temperature range (unless otherwise noted)†

Supply voltage, AV_{CC} (see Note 1) . . . . . 7 V
Differential input voltage, V_{ID} (see Note 2) . . . . . AV_{CC}
Input voltage range, V_I (any input) (see Notes 1 and 3) . . . . . –0.3 to AV_{CC}
Output voltage, V_O . . . . . –0.3 to AV_{CC}
Output current, I_O . . . . . 20 mA
Duration of short-circuit current at or below 25°C (output shorted to GND) . . . . . unlimited
Continuous total power dissipation, P_D ($T_A \le 25°C$) (see Note 4) . . . . . 625 mW
Operating free-air temperature range, T_A . . . . . 0°C to 70°C
Storage temperature range, T_{stg} . . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values, except differential voltage, are with respect to GND.
2. Differential voltage is at the noninverting input with respect to the inverting input.
3. All input voltage values must not exceed V_{CC}.
4. Derating factor above $T_A = 25°C$ is 10 mW/°C.

recommended operating conditions

	MIN	NOM	MAX	UNIT
Supply voltage, AV_{CC}	4.75	5	5.25	V
Input voltage range, V_I (see Note 5)	1.1		3.9	V
Operating free-air temperature, T_A	0		70	°C

NOTE 5: The output voltage is undetermined when the input voltage exceeds recommended input voltage range.

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 5 V (unless otherwise noted)

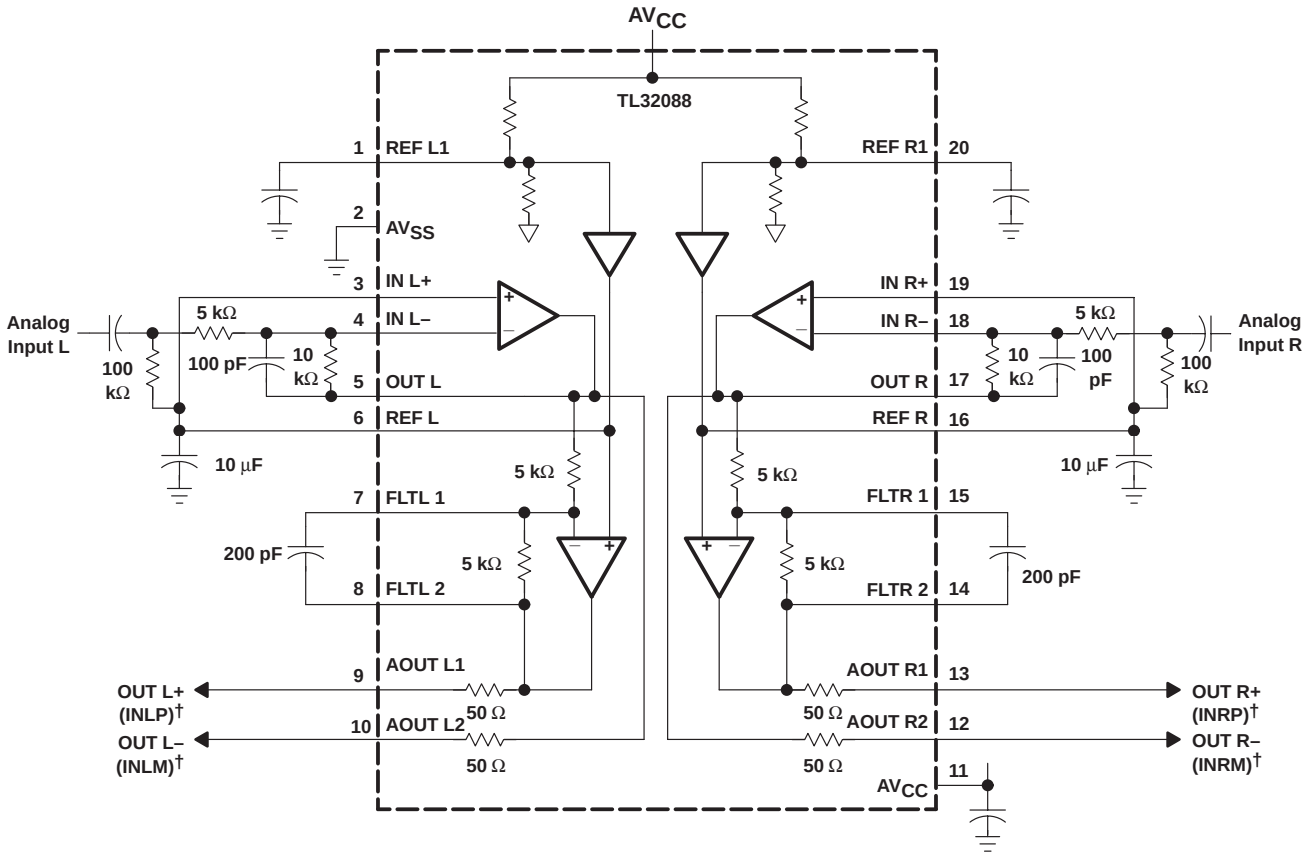
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 2.5 V, V_O = 2.5 V (AMP L1, R1)	T_A = 25°C		1	6	mV
			T_A = 0°C to 70°C			7.5	
I_{IO}	Input offset current	V_{IC} = 2.5 V, V_O = 2.5 V (AMP L1, R1)	T_A = 25°C		5	100	nA
			T_A = 0°C to 70°C			150	
I_{IB}	Input bias current	V_{IC} = 2.5 V, V_O = 2.5 V (AMP L1, R1)	T_A = 25°C		20	150	nA
			T_A = 0°C to 70°C			250	
V_{IC}	Common-mode input voltage	$V_O \le 7.5$ mV (AMP L1, R1)	T_A = 25°C	0.9		4.1	V
			T_A = 0°C to 70°C	1.1		3.9	
V_{OM+}	Maximum positive-peak output voltage			4.4			V
$V_{OM–}$	Maximum negative-peak output voltage					0.6	V
A_{vd}	Differential voltage amplification	V_O = 2.5 V ± 1 V (AMP L1, R1)	T_A = 25°C		60		dB
CMRR	Common-mode rejection ratio	V_O = 2.5 V ± 1 V (AMP L1, R1)	T_A = 25°C		85		dB
V_{ref}	Reference voltage			2.4	2.5	2.6	V
E_G	Gain error	See Note 6				±3%	
r_o	Output resistance		T_A = 25°C		50		Ω
I_{CC}	Supply current (both channels)	V_O = 2.5 V, No load	T_A = 25°C		17	20	mA
			T_A = 0°C to 70°C			25	

NOTE 6: Gain error is between OUT L and FLTL 1, OUT R and FLTR 1.

operating characteristics over recommended operating free-air temperature range, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Slew rate	A_V = 1, V_I = 2.5 V + 0.5 V (AMP L1, R1)		3		V/μs
B_1	Unity-gain bandwidth	AMP L1, R1		7		MHz
SNR	Signal-to-noise ratio (EIAJ)	A-Weighted test circuit (see Figure 2)	104	108		dB
THD+N	Total harmonic distortion plus noise	$V_{O(PP)}$ = 3.2 V f = 1 kHz, BW = 10 Hz to 20 kHz test circuit		0.00056%	0.001%	
	Crosstalk	$V_{O(PP)}$ = 3.2 V, f = 20 kHz		–125		dB

APPLICATION INFORMATION



† TLC320AD58C input terminals.

Figure 1. TL32088 to TLC320AD58C Connections

APPLICATION INFORMATION

Table 1. A-Weighted Data

FREQUENCY	A WEIGHTING (dB)	FREQUENCY	A WEIGHTING (dB)
25	–44.6 ±2	800	–0.1 ±1
31.5	–39.2 ±2	1000	0 ±0
40	–34.5 ±2	1250	0.6 ±1
50	–30.2 ±2	1600	1.0 ±1
63	–26.1 ±2	2000	1.2 ±1
80	–22.3 ±2	2500	1.2 ±1
100	–19.1 ±1	3150	1.2 ±1
125	–16.1 ±1	4000	1.0 ±1
160	–13.2 ±1	5000	0.5 ±1
200	–10.8 ±1	6300	–0.1 ±1
250	–8.6 ±1	8000	–1.1 ±1
315	–6.5 ±1	10000	–2.4 ±1
400	–4.8 ±1	12500	–4.2 ±2
500	–3.2 ±1	16000	–6.5 ±2
630	–1.9 ±1	—	—

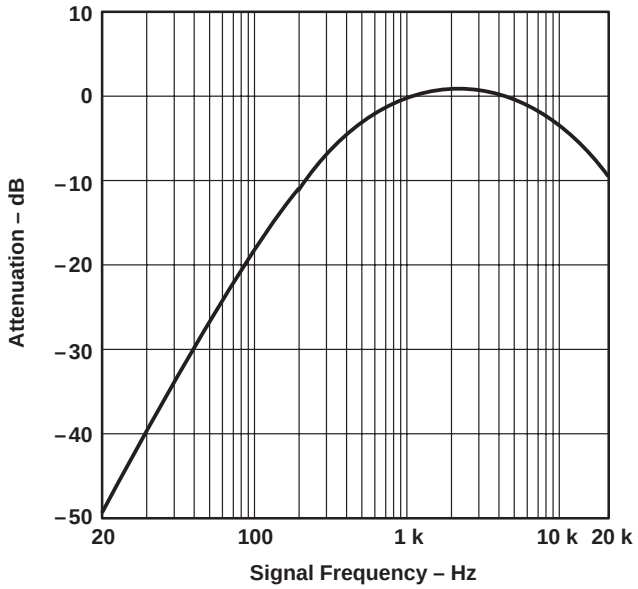
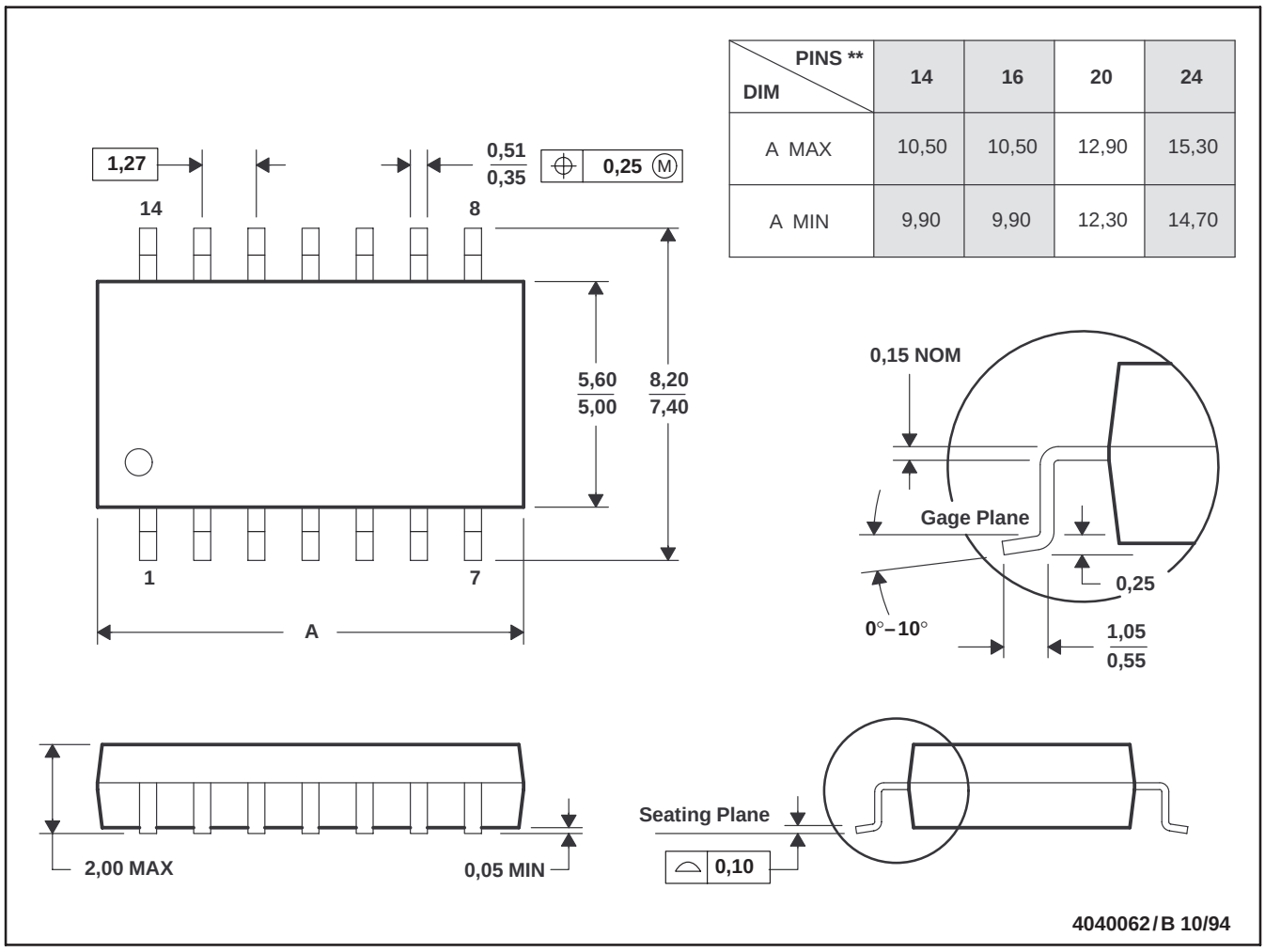


Figure 2. A-Weighted Function

MECHANICAL DATA

NS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TL32088CNSLE	OBSOLETE	SO	NS	20		TBD	Call TI	Call TI
TL32088CNSR	OBSOLETE	SO	NS	20		TBD	Call TI	Call TI

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

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