

## LM833-N Dual Audio Operational Amplifier

Check for Samples: [LM833-N](#)

### FEATURES

- **Wide Dynamic Range:** >140dB
- **Low Input Noise Voltage:**  $4.5\text{nV}/\sqrt{\text{Hz}}$
- **High Slew Rate:**  $7\text{ V}/\mu\text{s}$  (typ);  $5\text{ V}/\mu\text{s}$  (Min)
- **High Gain Bandwidth:** 15MHz (typ); 10MHz (Min)
- **Wide Power Bandwidth:** 120KHz
- **Low Distortion:** 0.002%
- **Low Offset Voltage:** 0.3mV
- **Large Phase Margin:**  $60^\circ$
- **Available in 8 Pin VSSOP Package**

### DESCRIPTION

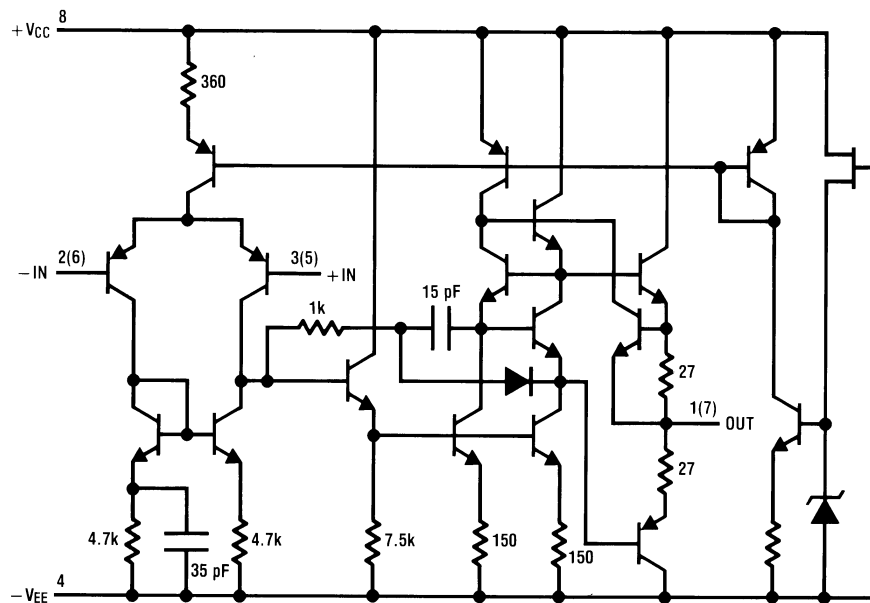
The LM833-N is a dual general purpose operational amplifier designed with particular emphasis on performance in audio systems.

This dual amplifier IC utilizes new circuit and processing techniques to deliver low noise, high speed and wide bandwidth without increasing external components or decreasing stability. The LM833-N is internally compensated for all closed loop gains and is therefore optimized for all preamp and high level stages in PCM and HiFi systems.

The LM833-N is pin-for-pin compatible with industry standard dual operational amplifiers.

### Schematic Diagram

(1/2 LM833-N)



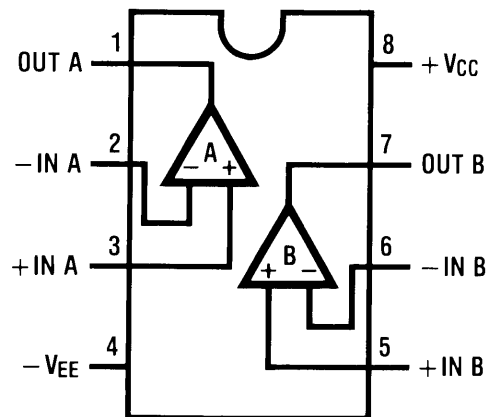
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## Connection Diagram



**Figure 1. See Package Number D0008A, P0008E or DGK0008A**



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## ABSOLUTE MAXIMUM RATINGS<sup>(1)(2)</sup>

Supply Voltage $V_{CC}-V_{EE}$			36V
Differential Input Voltage <sup>(3)</sup> $V_I$			±30V
Input Voltage Range <sup>(3)</sup> $V_{IC}$			±15V
Power Dissipation <sup>(4)</sup> $P_D$			500 mW
Operating Temperature Range $T_{OPR}$			−40 ~ 85°C
Storage Temperature Range $T_{STG}$			−60 ~ 150°C
Soldering Information	PDIP Package	Soldering (10 seconds)	260°C
	Small Outline Package (SOIC and VSSOP)	Vapor Phase (60 seconds)	215°C
		Infrared (15 seconds)	220°C
ESD tolerance <sup>(5)</sup>			1600V

- (1) *Absolute Maximum Ratings* indicate limits beyond which damage to the device may occur. *Operating Ratings* indicate conditions for which the device is functional, but do not ensure specific performance limits. *Electrical Characteristics* state DC and AC electrical specifications under particular test conditions which ensure specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not ensured for parameters where no limit is given, however, the typical value is a good indication of device performance.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (3) If supply voltage is less than  $\pm 15V$ , it is equal to supply voltage.
- (4) This is the permissible value at  $T_A \leq 85^{\circ}C$ .
- (5) Human body model, 1.5 k $\Omega$  in series with 100 pF.

## DC ELECTRICAL CHARACTERISTICS<sup>(1)(2)</sup>

 $(T_A = 25^\circ\text{C}, V_S = \pm 15\text{V})$ 

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_{OS}$	Input Offset Voltage	$R_S = 10\Omega$		0.3	5	mV
$I_{OS}$	Input Offset Current			10	200	nA
$I_B$	Input Bias Current			500	1000	nA
$A_V$	Voltage Gain	$R_L = 2\text{ k}\Omega, V_O = \pm 10\text{V}$	90	110		dB
$V_{OM}$	Output Voltage Swing	$R_L = 10\text{ k}\Omega$	$\pm 12$	$\pm 13.5$		V
		$R_L = 2\text{ k}\Omega$	$\pm 12$	$\pm 13.4$		V
$V_{CM}$	Input Common-Mode Range		$\pm 12$	$\pm 14.0$		V
CMRR	Common-Mode Rejection Ratio	$V_{IN} = \pm 12\text{V}$	80	100		dB
PSRR	Power Supply Rejection Ratio	$V_S = 15 \sim 5\text{V}, -15 \sim -5\text{V}$	80	100		dB
$I_Q$	Supply Current	$V_O = 0\text{V}$ , Both Amps		5	8	mA

- (1) *Absolute Maximum Ratings* indicate limits beyond which damage to the device may occur. *Operating Ratings* indicate conditions for which the device is functional, but do not ensure specific performance limits. *Electrical Characteristics* state DC and AC electrical specifications under particular test conditions which ensure specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not ensured for parameters where no limit is given, however, the typical value is a good indication of device performance.
- (2) All voltages are measured with respect to the ground pin, unless otherwise specified.

## AC ELECTRICAL CHARACTERISTICS

 $(T_A = 25^\circ\text{C}, V_S = \pm 15\text{V}, R_L = 2\text{ k}\Omega)$ 

Symbol	Parameter	Conditions	Min	Typ	Max	Units
SR	Slew Rate	$R_L = 2\text{ k}\Omega$	5	7		V/ $\mu\text{s}$
GBW	Gain Bandwidth Product	$f = 100\text{ kHz}$	10	15		MHz
$V_{NI}$	Equivalent Input Noise Voltage (LM833AM, LM833AMX)	RIAA, $R_S = 2.2\text{ k}\Omega$ <sup>(1)</sup>			1.4	$\mu\text{V}$

- (1) RIAA Noise Voltage Measurement Circuit

## DESIGN ELECTRICAL CHARACTERISTICS

 $(T_A = 25^\circ\text{C}, V_S = \pm 15\text{V})$ 

The following parameters are not tested or ensured.

Symbol	Parameter	Conditions	Typ	Units
$\Delta V_{OS}/\Delta T$	Average Temperature Coefficient of Input Offset Voltage		2	$\mu\text{V}/^\circ\text{C}$
THD	Distortion	$R_L = 2\text{ k}\Omega, f = 20\sim 20\text{ kHz}$ $V_{OUT} = 3\text{ V}_{rms}, A_V = 1$	0.002	%
$e_n$	Input Referred Noise Voltage	$R_S = 100\Omega, f = 1\text{ kHz}$	4.5	$\text{nV} / \sqrt{\text{Hz}}$
$i_n$	Input Referred Noise Current	$f = 1\text{ kHz}$	0.7	$\text{pA} / \sqrt{\text{Hz}}$
PBW	Power Bandwidth	$V_O = 27\text{ V}_{pp}, R_L = 2\text{ k}\Omega, \text{THD} \leq 1\%$	120	kHz
$f_U$	Unity Gain Frequency	Open Loop	9	MHz
$\phi_M$	Phase Margin	Open Loop	60	deg
	Input Referred Cross Talk	$f = 20\sim 20\text{ kHz}$	-120	dB

## TYPICAL PERFORMANCE CHARACTERISTICS

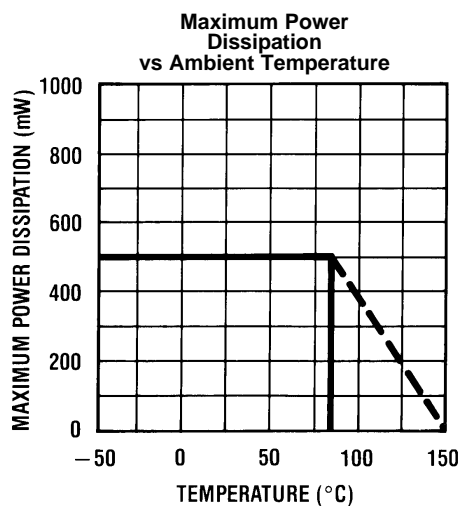


Figure 2.

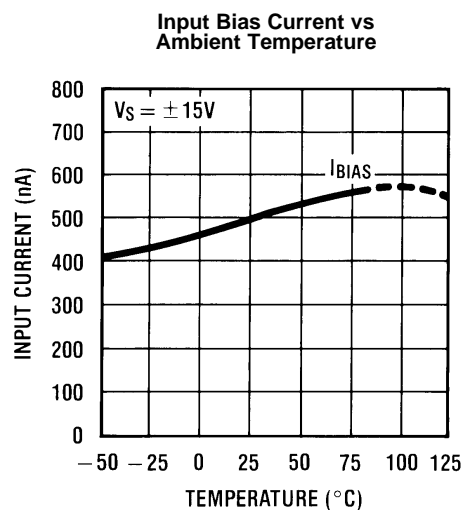


Figure 3.

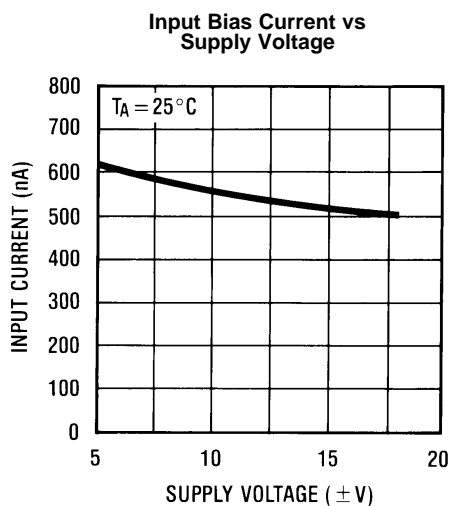


Figure 4.

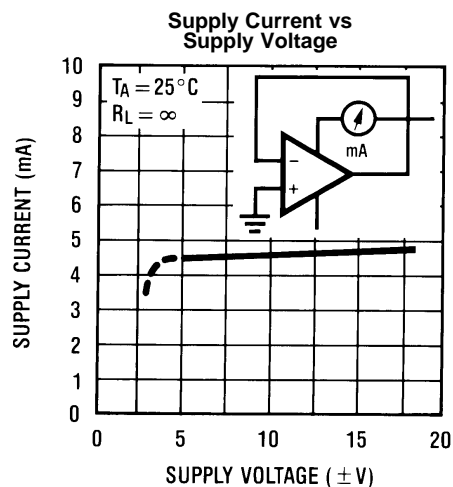


Figure 5.

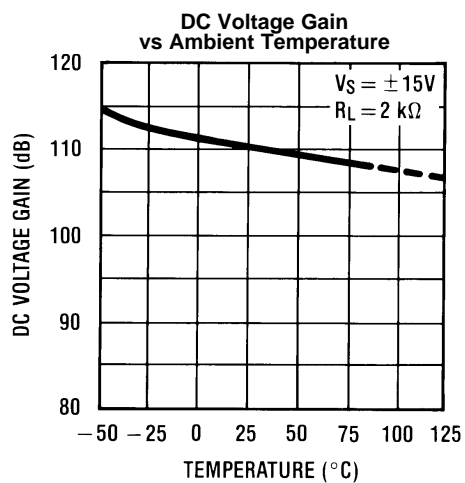


Figure 6.

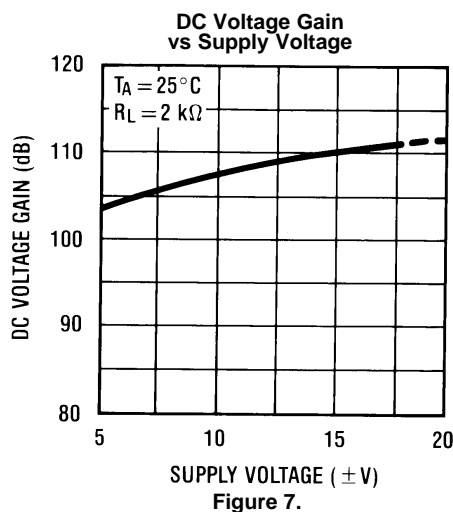


Figure 7.

# TYPICAL PERFORMANCE CHARACTERISTICS (continued)

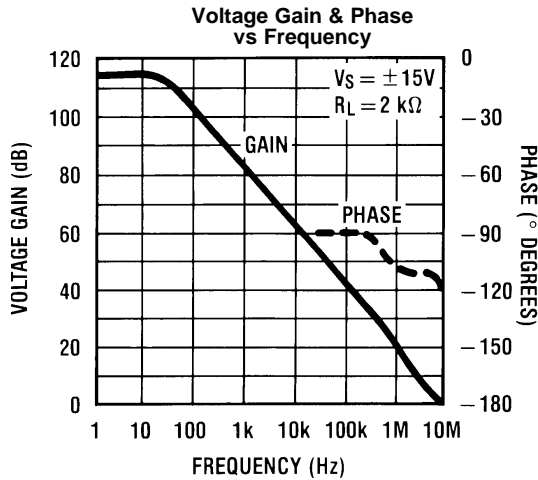


Figure 8.

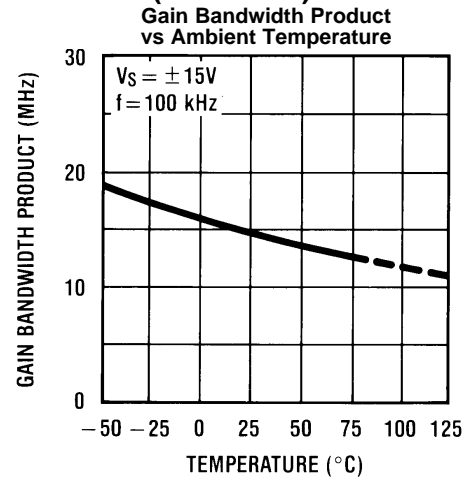


Figure 9.

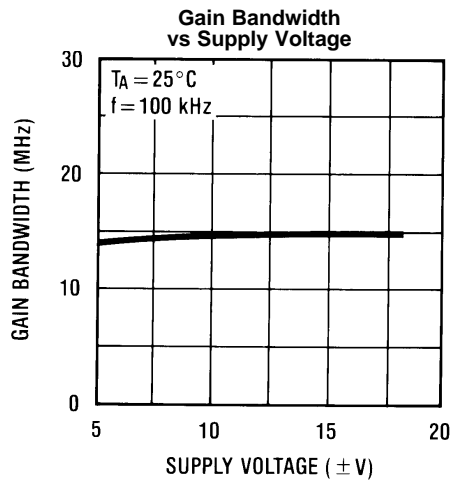


Figure 10.

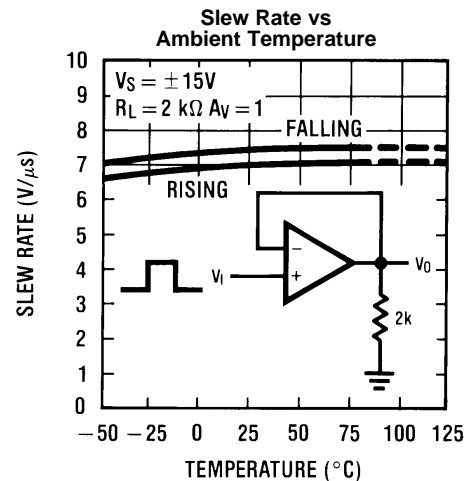


Figure 11.

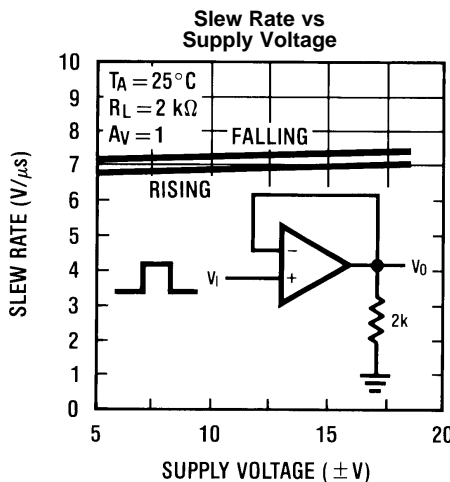


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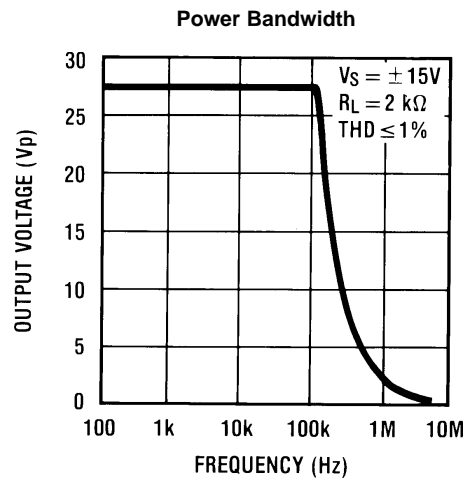


Figure 13.

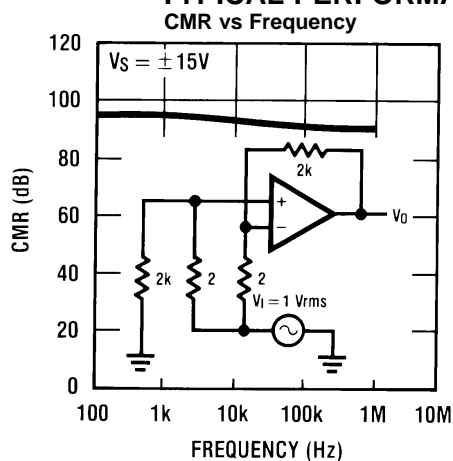
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

Figure 14.

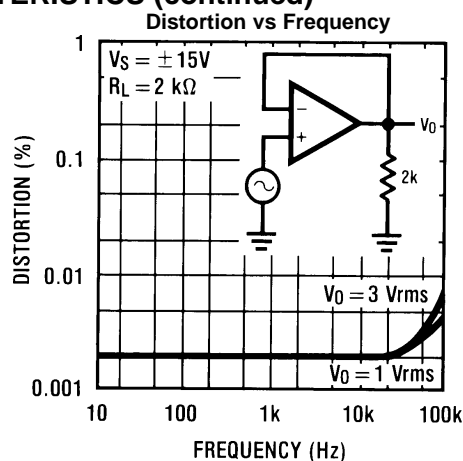


Figure 15.

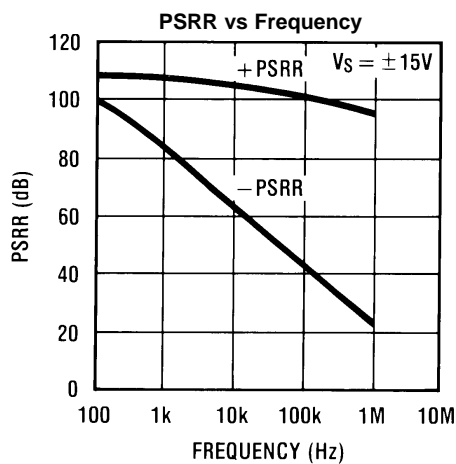


Figure 16.

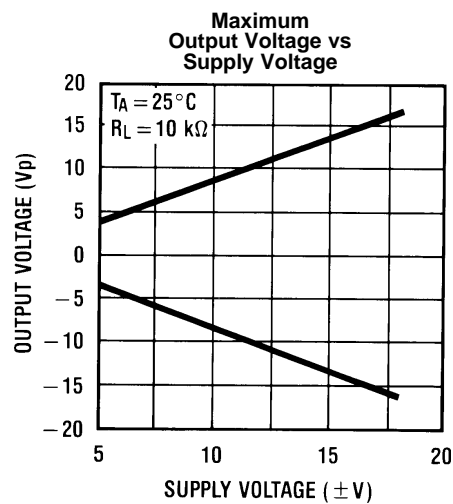


Figure 17.

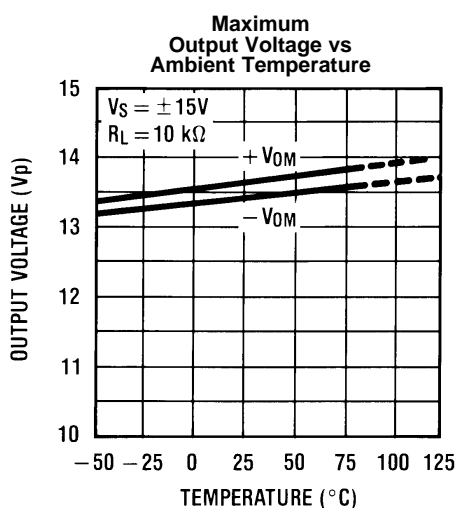


Figure 18.

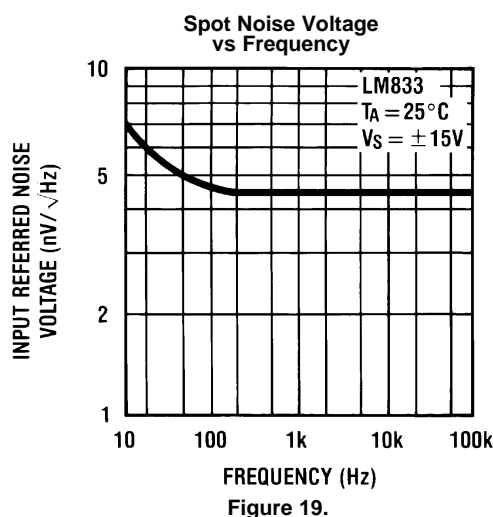


Figure 19.

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Spot Noise Current  
vs Frequency

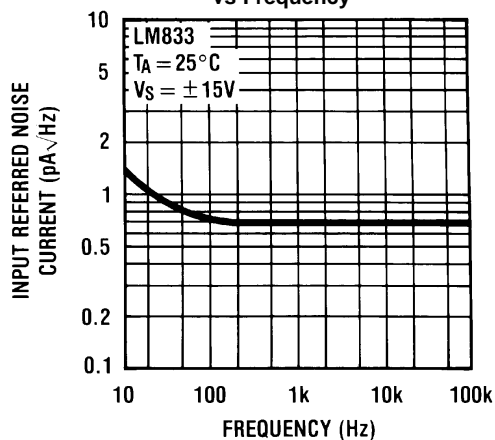


Figure 20.

Input Referred Noise Voltage  
vs Source Resistance

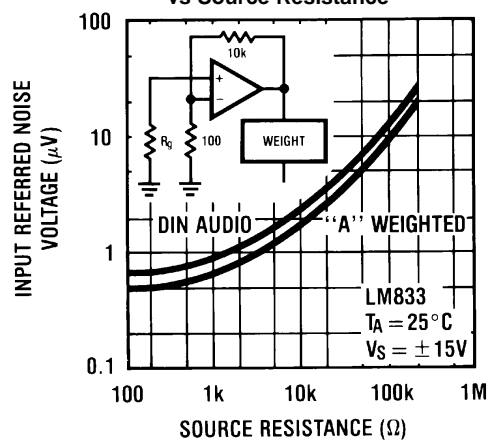
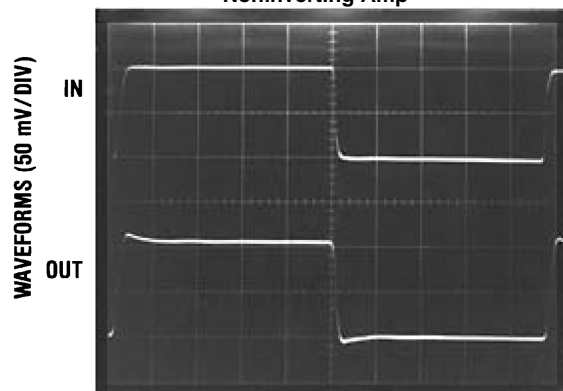


Figure 21.

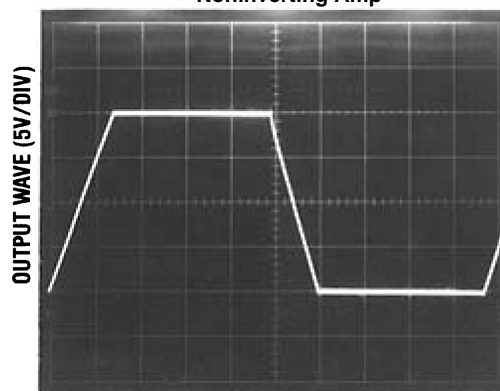
Noninverting Amp



TIME (0.2  $\mu$ s/DIV)

Figure 22.

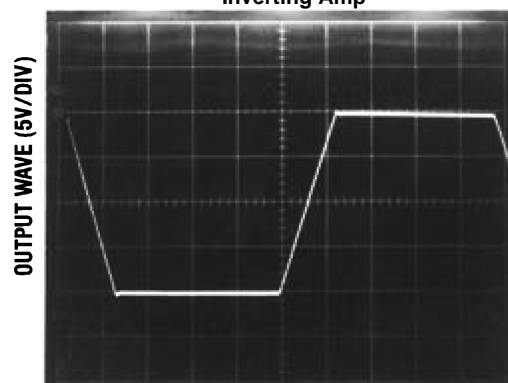
Noninverting Amp



TIME (2  $\mu$ s/DIV)

Figure 23.

Inverting Amp



TIME (2  $\mu$ s/DIV)

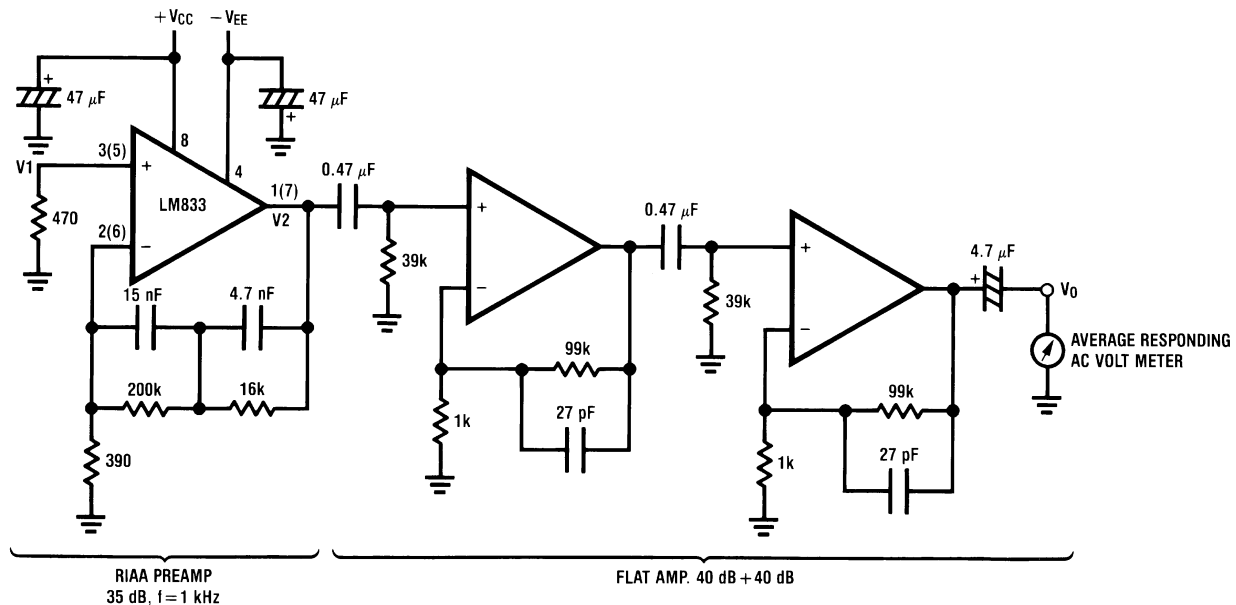
Figure 24.

## APPLICATION HINTS

The LM833-N is a high speed op amp with excellent phase margin and stability. Capacitive loads up to 50 pF will cause little change in the phase characteristics of the amplifiers and are therefore allowable.

Capacitive loads greater than 50 pF must be isolated from the output. The most straightforward way to do this is to put a resistor in series with the output. This resistor will also prevent excess power dissipation if the output is accidentally shorted.

### Noise Measurement Circuit



Complete shielding is required to prevent induced pick up from external sources. Always check with oscilloscope for power line noise.

**Figure 25. Total Gain: 115 dB @  $f = 1$  kHz**  
**Input Referred Noise Voltage:  $e_n = V_0/560,000$  (V)**



## RIAA Noise Voltage Measurement Circuit

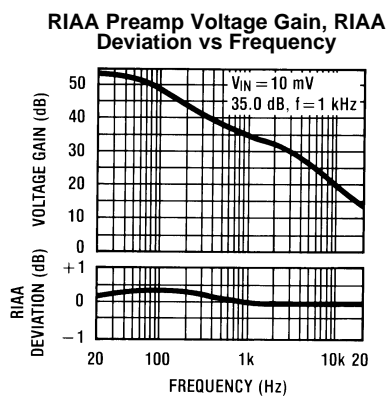
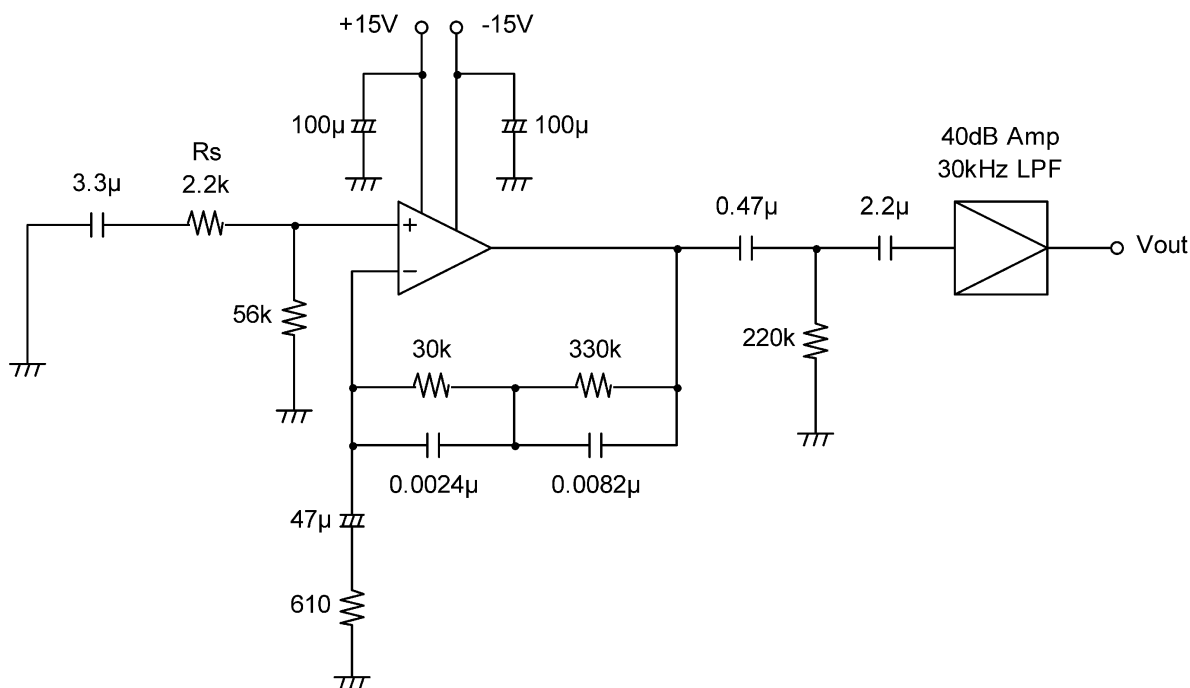


Figure 26.

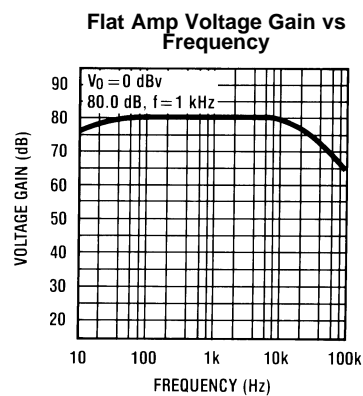
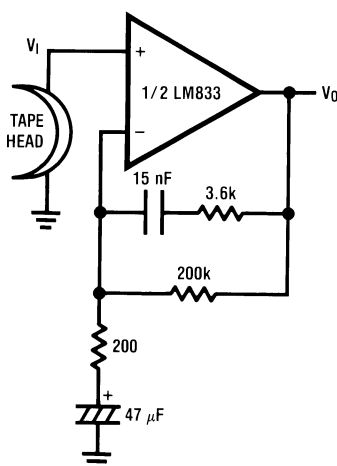


Figure 27.

## Typical Applications



$A_V = 34.5$   
 $F = 1 \text{ kHz}$   
 $E_n = 0.38 \mu\text{V}$   
 A Weighted

Figure 28. NAB Preamp

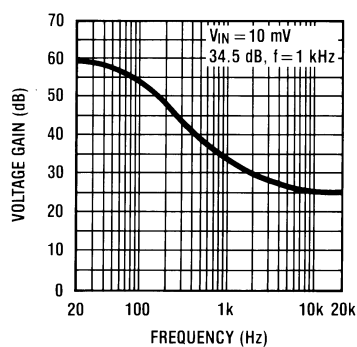
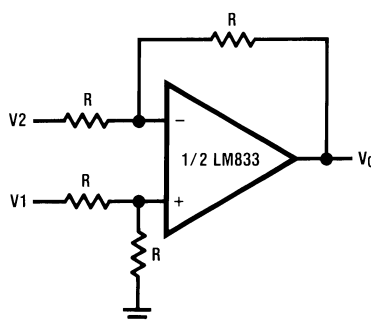
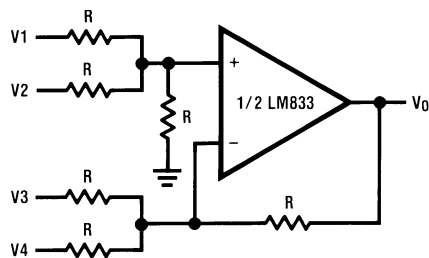


Figure 29. NAB Preamp Voltage Gain vs Frequency



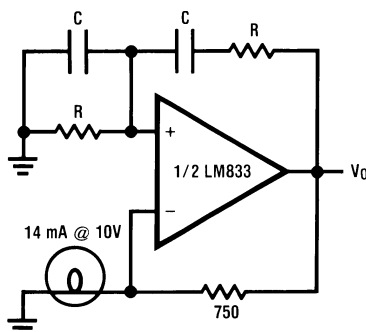
$$V_O = V_1 - V_2$$

Figure 30. Balanced to Single Ended Converter



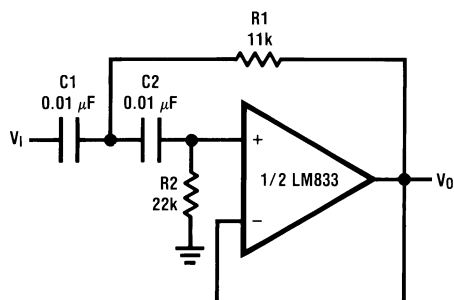
$$V_O = V_1 + V_2 - V_3 - V_4$$

Figure 31. Adder/Subtractor



$$f_o = \frac{1}{2\pi RC}$$

Figure 32. Sine Wave Oscillator



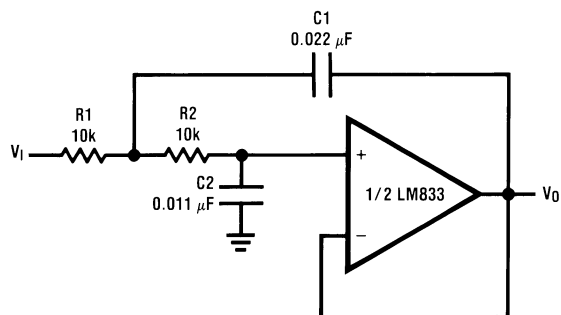
$$\text{if } C_1 = C_2 = C$$

$$R_1 = \frac{\sqrt{2}}{2\omega_o C}$$

$$R_2 = 2 \cdot R_1$$

Illustration is  $f_o = 1 \text{ kHz}$

Figure 33. Second Order High Pass Filter (Butterworth)



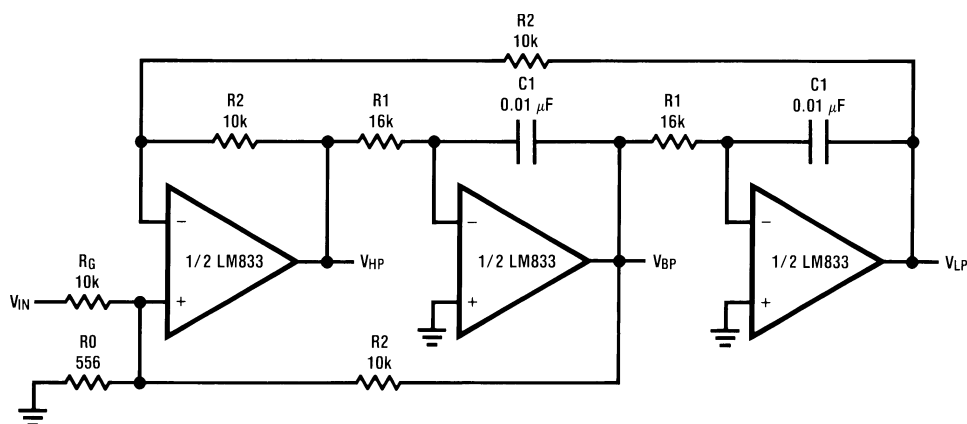
if  $R_1 = R_2 = R$

$$C_1 = \frac{\sqrt{2}}{\omega_o R}$$

$$C_2 = \frac{C_1}{2}$$

Illustration is  $f_0 = 1 \text{ kHz}$

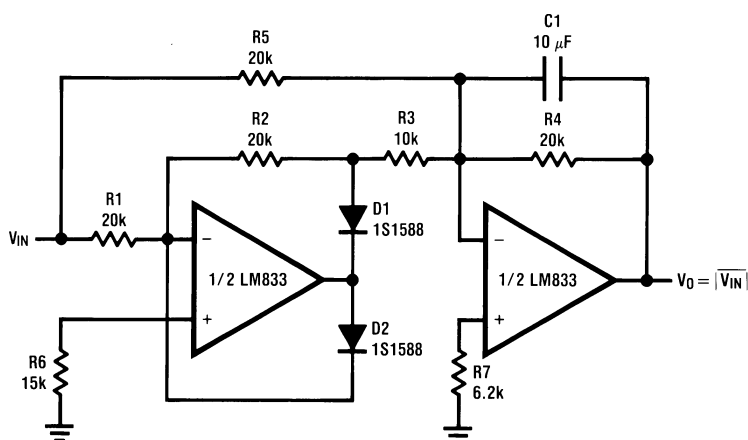
**Figure 34. Second Order Low Pass Filter (Butterworth)**



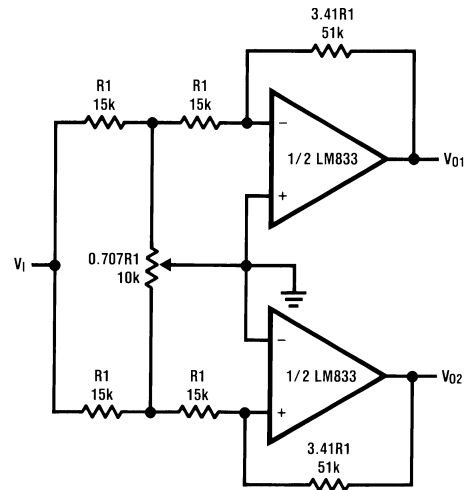
$$f_0 = \frac{1}{2\pi C_1 R_1}, Q = \frac{1}{2} \left( 1 + \frac{R_2}{R_0} + \frac{R_2}{R_G} \right), A_{BP} = Q A_{LP} = Q A_{LH} = \frac{R_2}{R_G}$$

Illustration is  $f_0 = 1 \text{ kHz}$ ,  $Q = 10$ ,  $A_{BP} = 1$

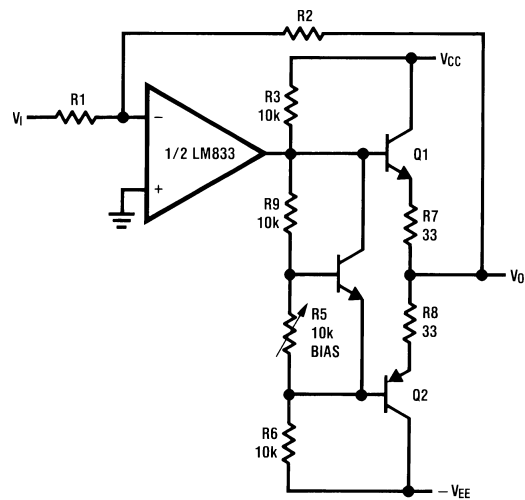
**Figure 35. State Variable Filter**



**Figure 36. AC/DC Converter**



**Figure 37. 2 Channel Panning Circuit (Pan Pot)**



**Figure 38. Line Driver**

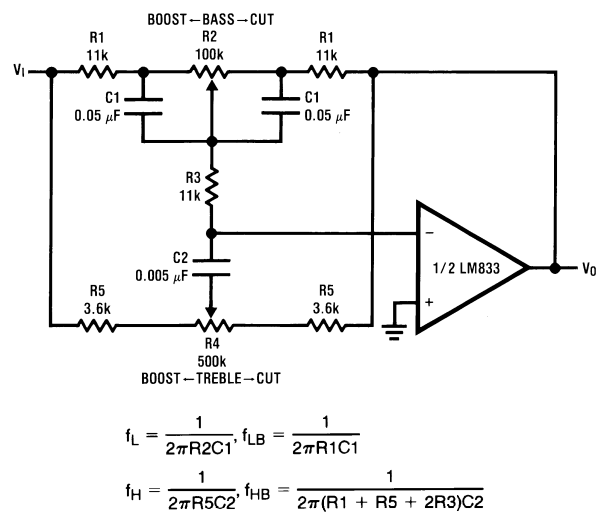


Illustration is:

$$f_L = 32 \text{ Hz}, f_{LB} = 320 \text{ Hz}$$

$$f_H = 11 \text{ kHz}, f_{HB} = 1.1 \text{ kHz}$$

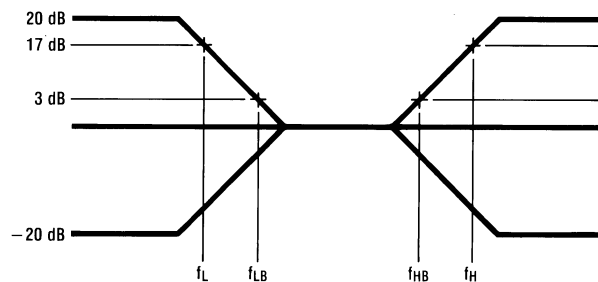
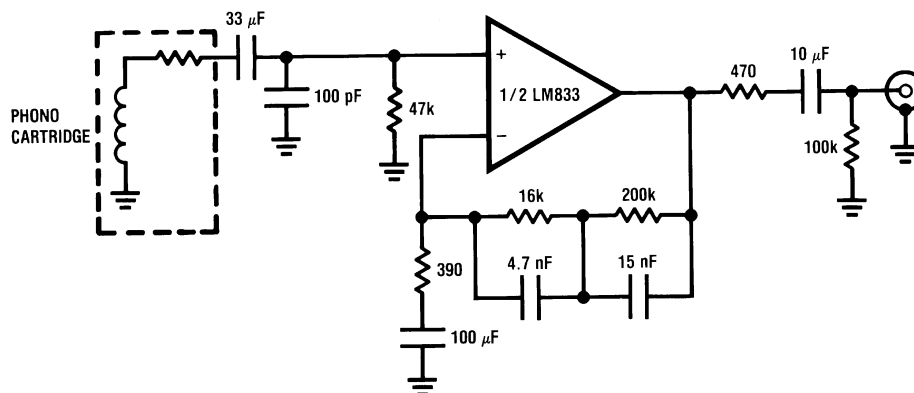


Figure 39. Tone Control



$$A_v = 35 \text{ dB}$$

$$E_n = 0.33 \text{ } \mu\text{V}$$

$$S/N = 90 \text{ dB}$$

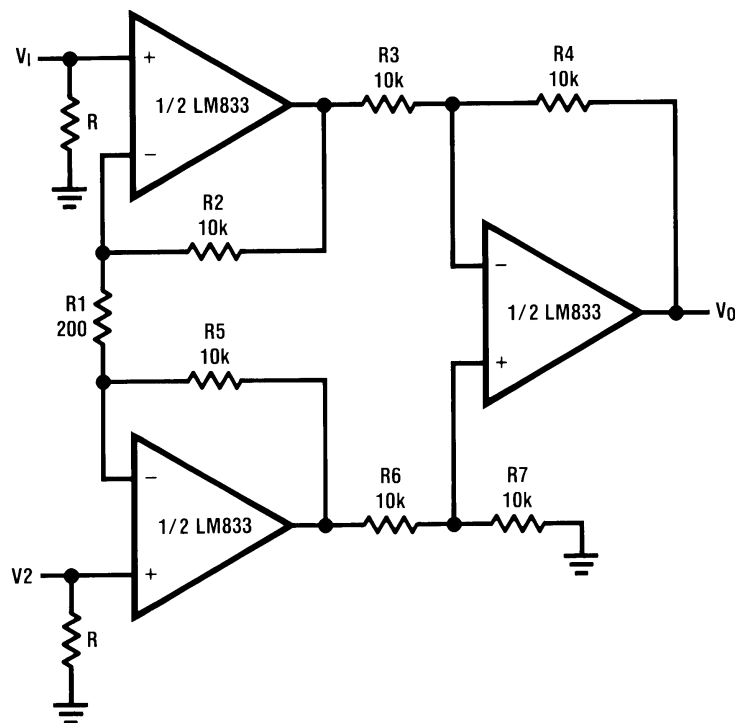
$$f = 1 \text{ kHz}$$

A Weighted

$$A \text{ Weighted}, V_{IN} = 10 \text{ mV}$$

$$@f = 1 \text{ kHz}$$

Figure 40. RIAA Preamplifier



If  $R2 = R5$ ,  $R3 = R6$ ,  $R4 = R7$

$$V_0 = \left(1 + \frac{2R2}{R1}\right) \frac{R4}{R3} (V2 - V1)$$

Illustration is:

$$V_0 = 101(V2 - V1)$$

**Figure 41. Balanced Input Mic Amp**

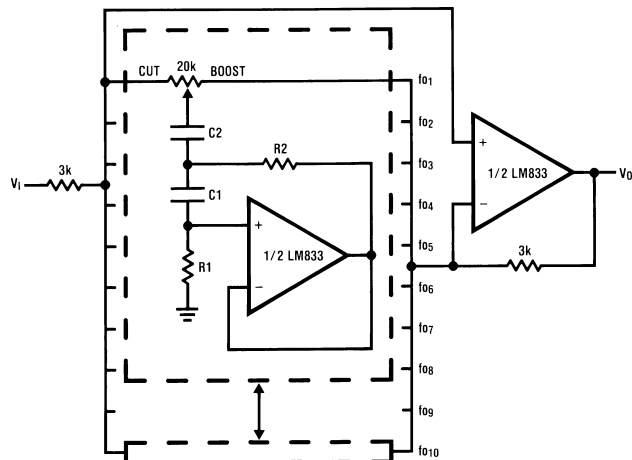


Figure 42. 10 Band Graphic Equalizer

fo (Hz)	C <sub>1</sub>	C <sub>2</sub>	R <sub>1</sub>	R <sub>2</sub>
32	0.12μF	4.7μF	75kΩ	500Ω
64	0.056μF	3.3μF	68kΩ	510Ω
125	0.033μF	1.5μF	62kΩ	510Ω
250	0.015μF	0.82μF	68kΩ	470Ω
500	8200pF	0.39μF	62kΩ	470Ω
1k	3900pF	0.22μF	68kΩ	470Ω
2k	2000pF	0.1μF	68kΩ	470Ω
4k	1100pF	0.056μF	62kΩ	470Ω
8k	510pF	0.022μF	68kΩ	510Ω
16k	330pF	0.012μF	51kΩ	510Ω

**Note:** At volume of change = ±12  
dB Q = 1.

**LM833-N MDC MWC DUAL AUDIO OPERATIONAL AMPLIFIER**

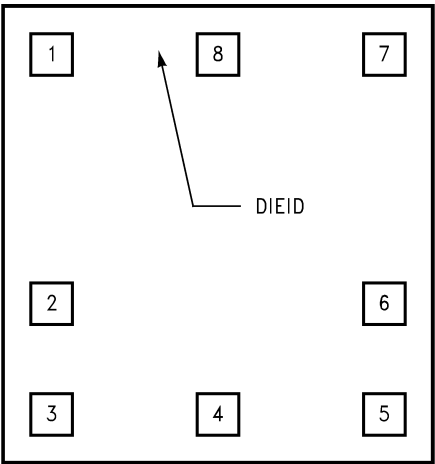


Figure 43. Die Layout (A - Step)



## PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">LM833M</a>	Active	Production	SOIC (D)   8	95   TUBE	No	Call TI	Level-1-235C-UNLIM	-40 to 85	LM833 M
<a href="#">LM833M/NOPB</a>	Active	Production	SOIC (D)   8	95   TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM833 M
<a href="#">LM833MM/NOPB</a>	Active	Production	VSSOP (DGK)   8	1000   SMALL T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	Z83
<a href="#">LM833MMX/NOPB</a>	Active	Production	VSSOP (DGK)   8	3500   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	Z83
<a href="#">LM833MX/NOPB</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM833 M
<a href="#">LM833N/NOPB</a>	Active	Production	PDIP (P)   8	40   TUBE	Yes	NIPDAU	Level-1-NA-UNLIM	-40 to 85	LM 833N

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

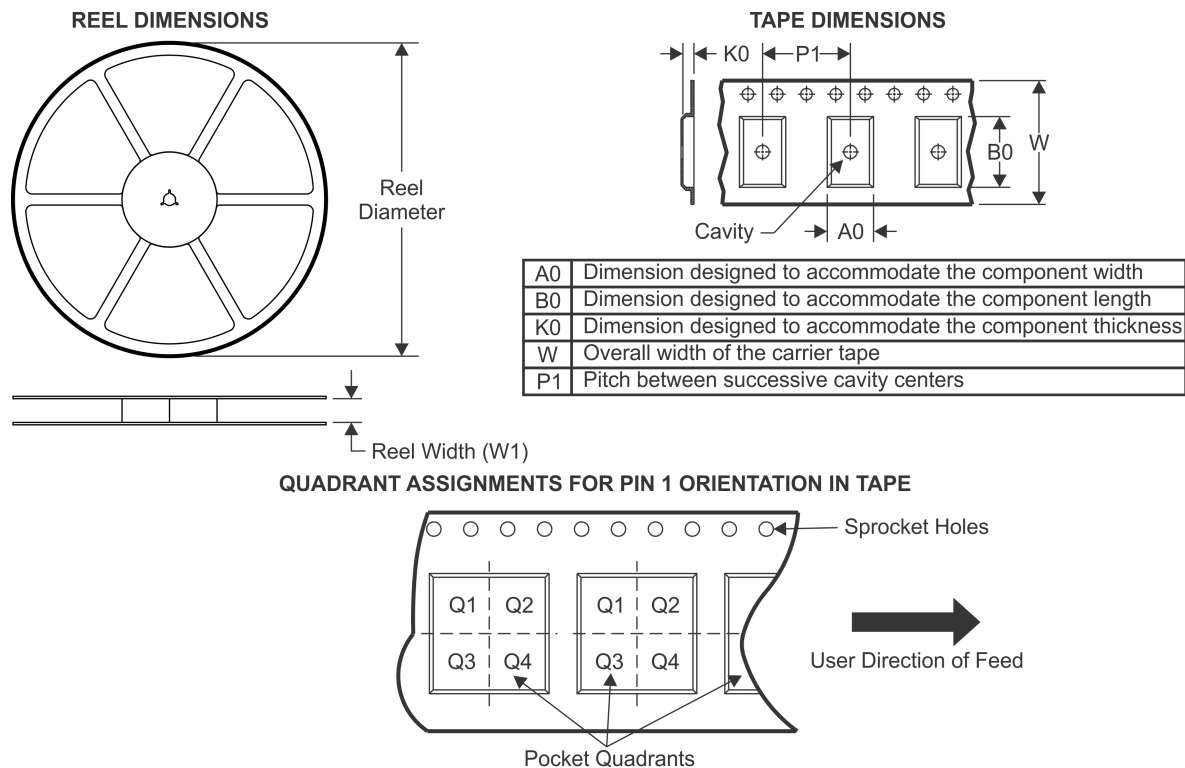
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

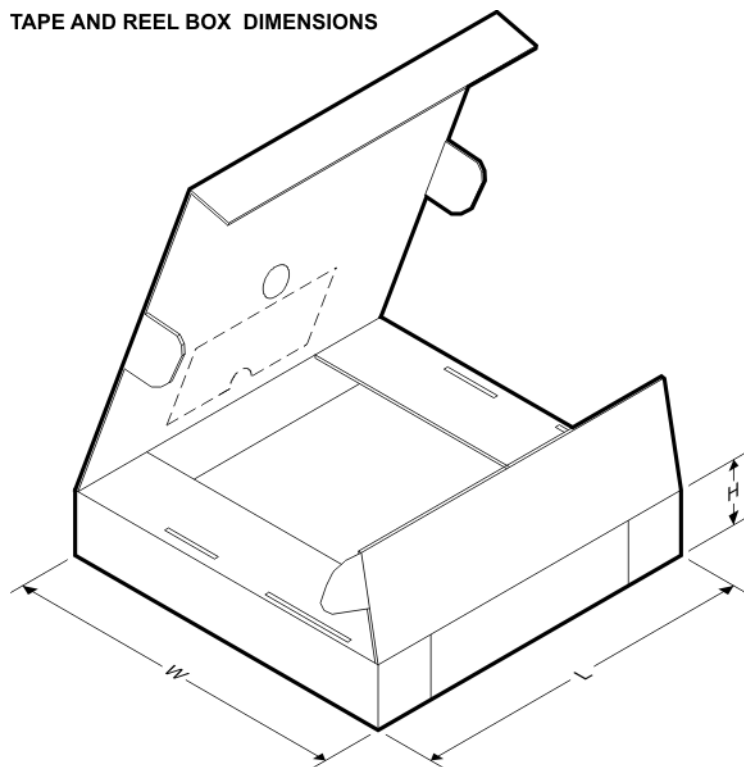
## TAPE AND REEL INFORMATION



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM833MM/NOPB	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM833MMX/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM833MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

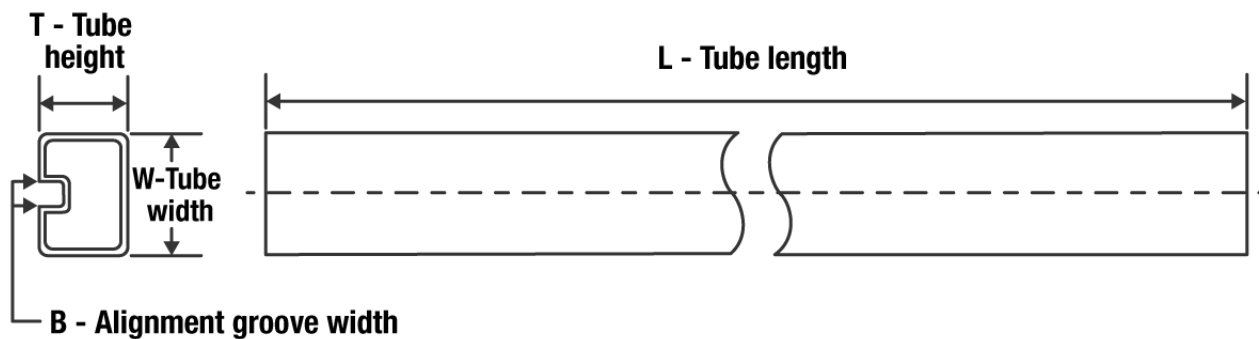
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

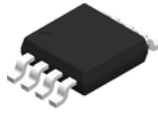
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM833MM/NOPB	VSSOP	DGK	8	1000	208.0	191.0	35.0
LM833MMX/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LM833MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

## TUBE

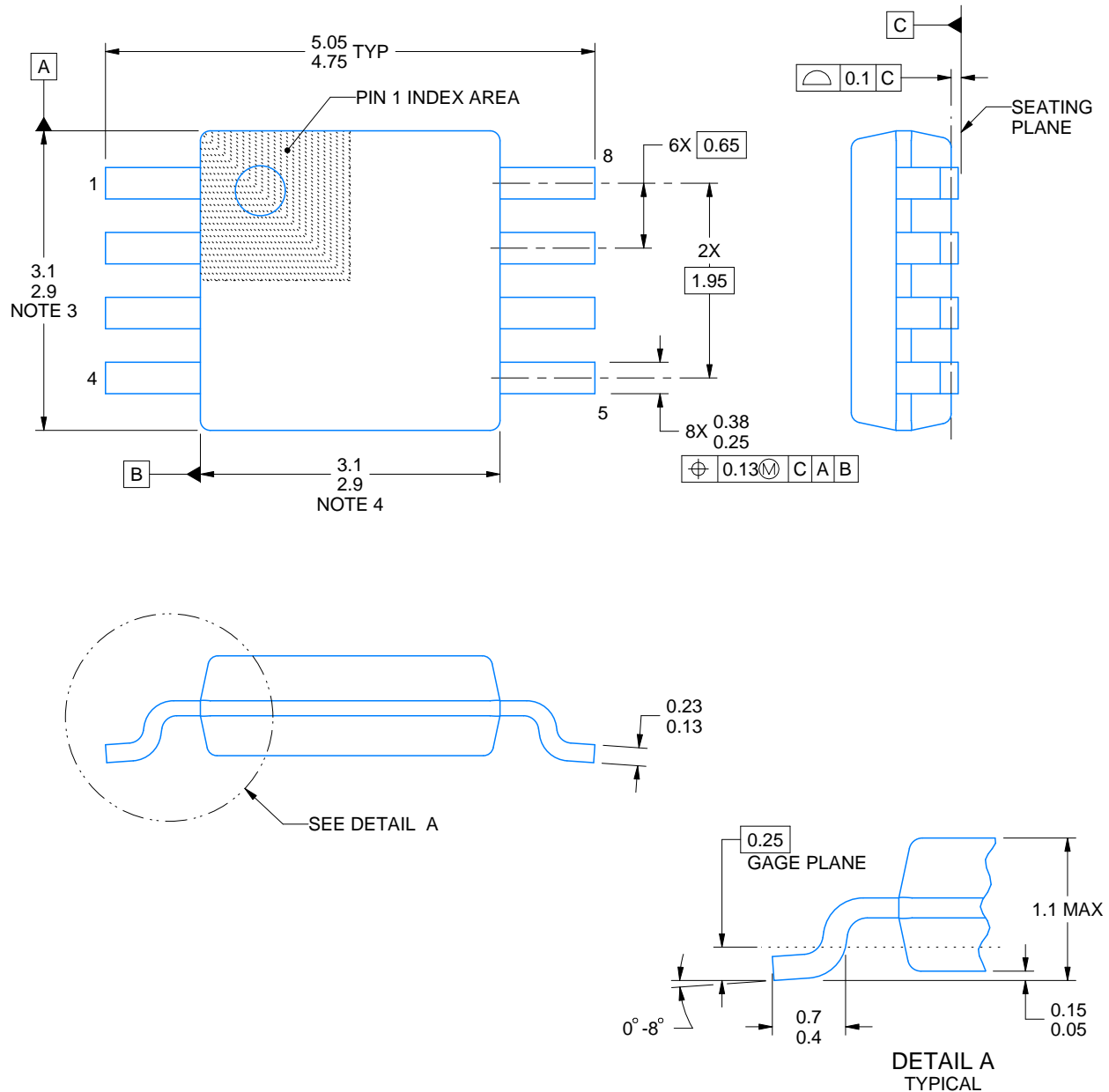


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
LM833M	D	SOIC	8	95	495	8	4064	3.05
LM833M	D	SOIC	8	95	495	8	4064	3.05
LM833M/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM833N/NOPB	P	PDIP	8	40	502	14	11938	4.32

**DGK0008A****PACKAGE OUTLINE****VSSOP - 1.1 mm max height**

SMALL OUTLINE PACKAGE



4214862/A 04/2023

**NOTES:**

PowerPAD is a trademark of Texas Instruments.

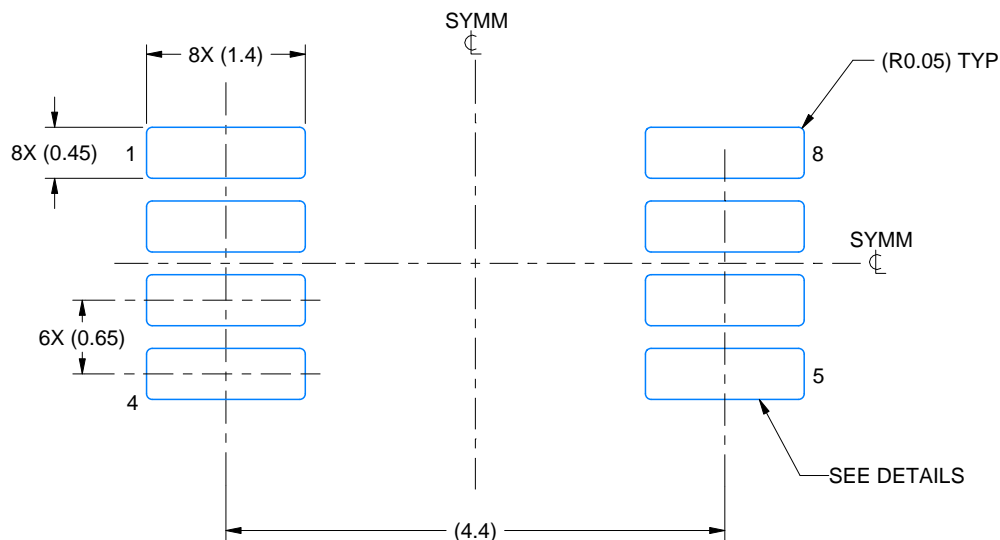
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.

# EXAMPLE BOARD LAYOUT

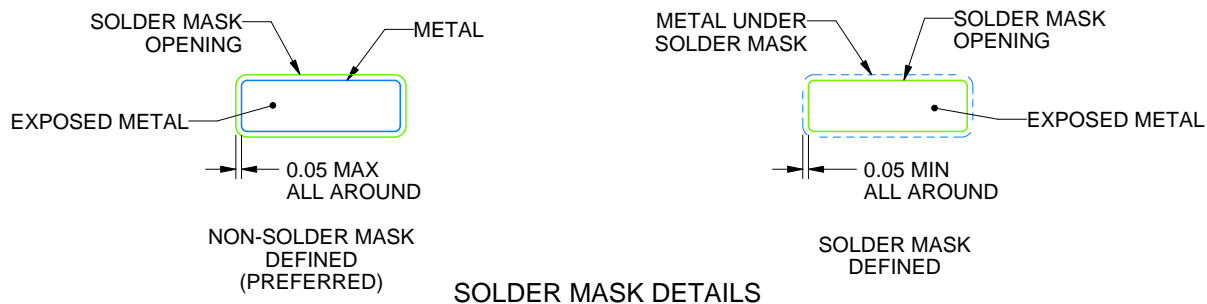
DGK0008A

™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 15X



4214862/A 04/2023

NOTES: (continued)

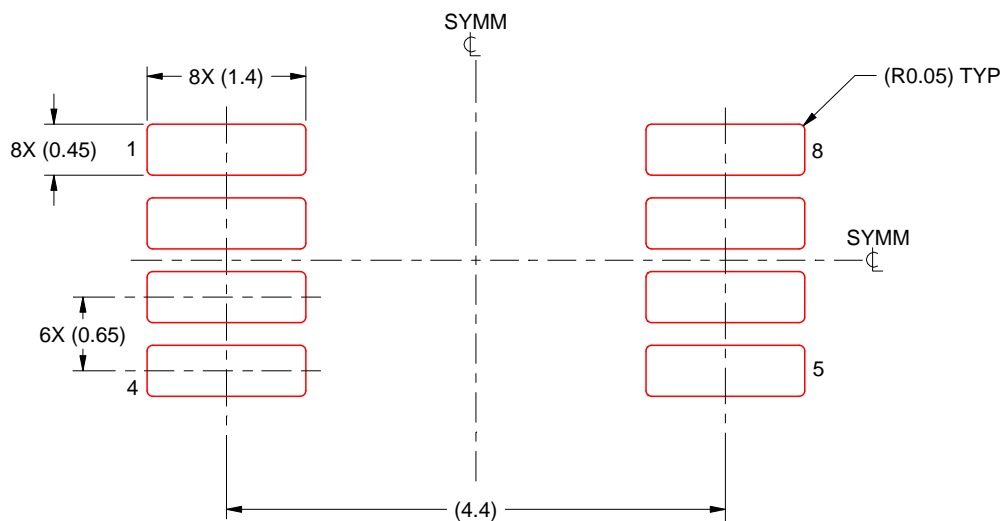
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.

## EXAMPLE STENCIL DESIGN

DGK0008A

<sup>TM</sup> VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
SCALE: 15X

4214862/A 04/2023

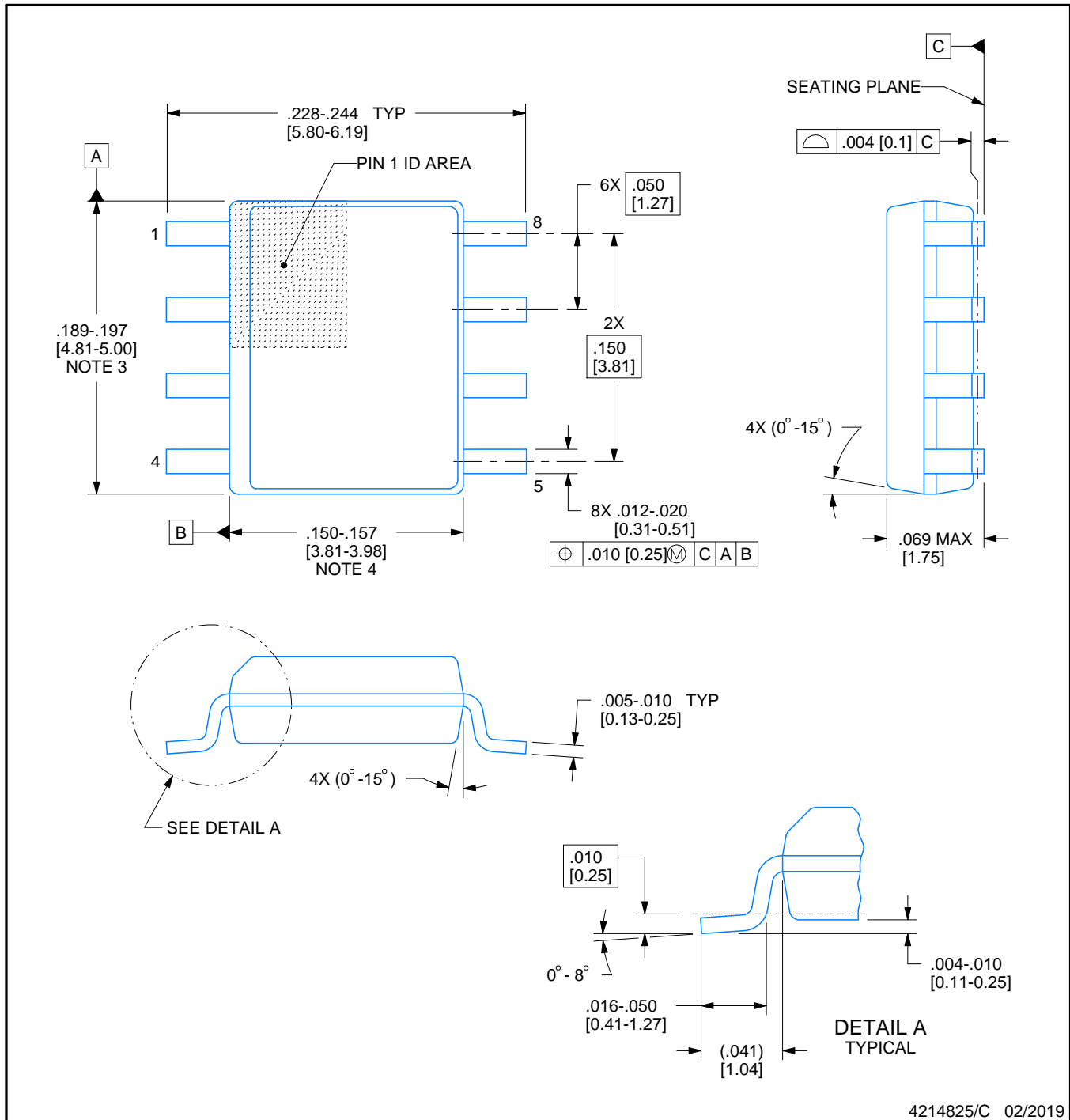
NOTES: (continued)

11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
12. Board assembly site may have different recommendations for stencil design.



**D0008A****PACKAGE OUTLINE****SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

**NOTES:**

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

# EXAMPLE BOARD LAYOUT

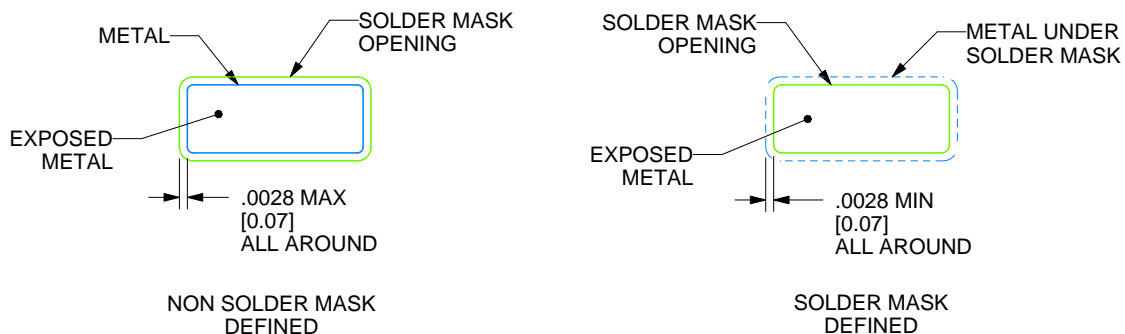
D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

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