

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°
- **Available in 8 Pin VSSOP Package**

DESCRIPTION

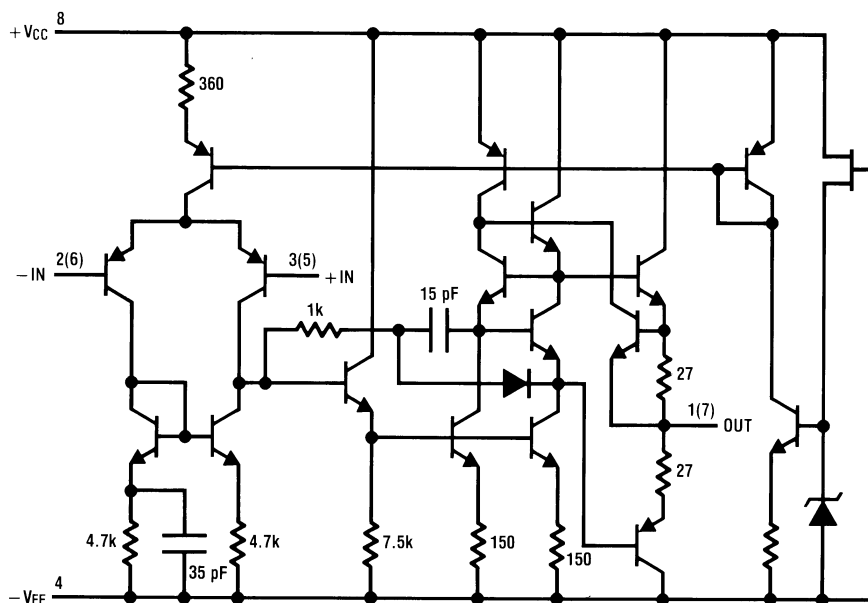
The LM833-N is a dual general purpose operational amplifier designed with particular emphasis on performance in audio systems.

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

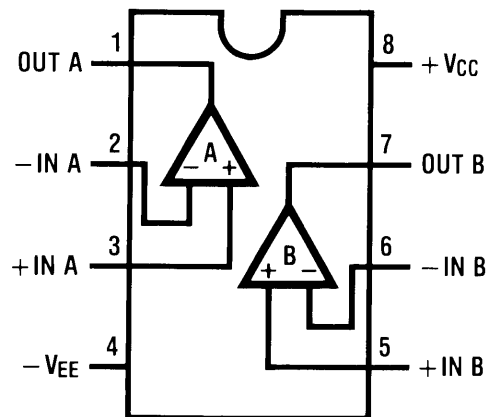


Figure 1. See Package Number D0008A, P0008E or DGK0008A



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⁽¹⁾⁽²⁾

| | | | |
|---|--|--------------------------|-------|
| Supply Voltage $V_{CC}-V_{EE}$ | | 36V | |
| Differential Input Voltage ⁽³⁾ V_I | | $\pm 30V$ | |
| Input Voltage Range ⁽³⁾ V_{IC} | | $\pm 15V$ | |
| Power Dissipation ⁽⁴⁾ P_D | | 500 mW | |
| Operating Temperature Range T_{OPR} | | $-40 \sim 85^\circ C$ | |
| Storage Temperature Range T_{STG} | | $-60 \sim 150^\circ C$ | |
| 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 ⁽⁵⁾ | | 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 Ω in series with 100 pF.

DC ELECTRICAL CHARACTERISTICS⁽¹⁾⁽²⁾

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

| 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 | $R_L = 10\text{ k}\Omega$ | ± 12 | ± 13.5 | | V |
| | | $R_L = 2\text{ k}\Omega$ | ± 12 | ± 13.4 | | V |
| V_{CM} | Input Common-Mode Range | | ± 12 | ± 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/ μs |
| GBW | Gain Bandwidth Product | $f = 100\text{ kHz}$ | 10 | 15 | | MHz |
| V_{NI} | Equivalent Input Noise Voltage (LM833AM, LM833AMX) | RIAA, $R_S = 2.2\text{ k}\Omega$ ⁽¹⁾ | | | 1.4 | μV |

- (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 |
| Φ_M | Phase Margin | Open Loop | 60 | deg |
| | Input Referred Cross Talk | $f = 20\sim 20\text{ kHz}$ | -120 | dB |

TYPICAL PERFORMANCE CHARACTERISTICS

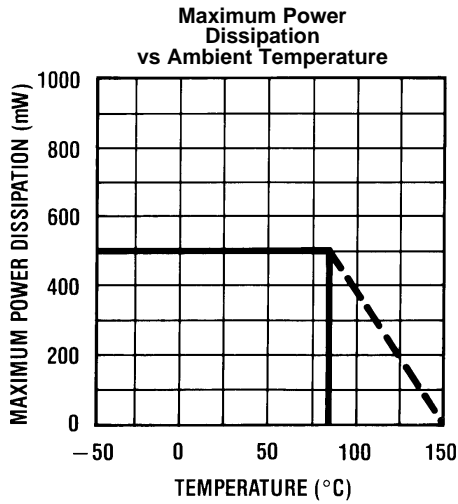


Figure 2.

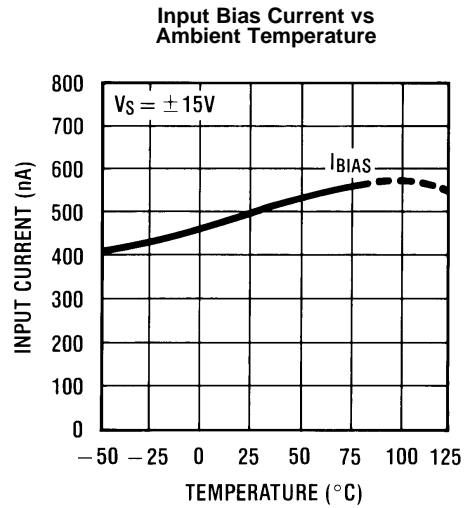


Figure 3.

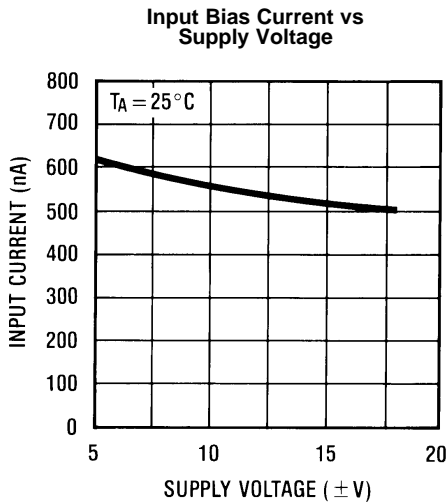


Figure 4.

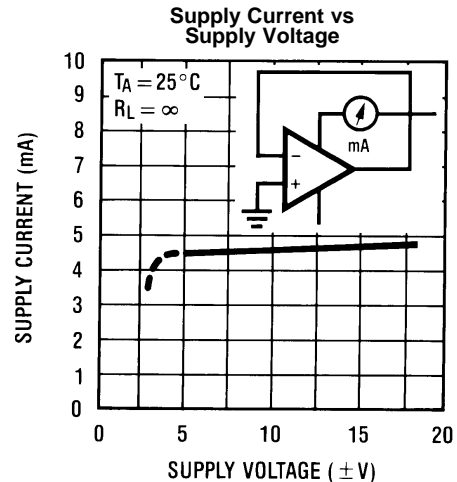


Figure 5.

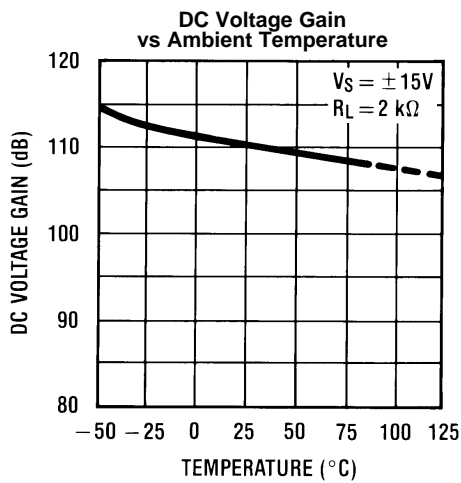


Figure 6.

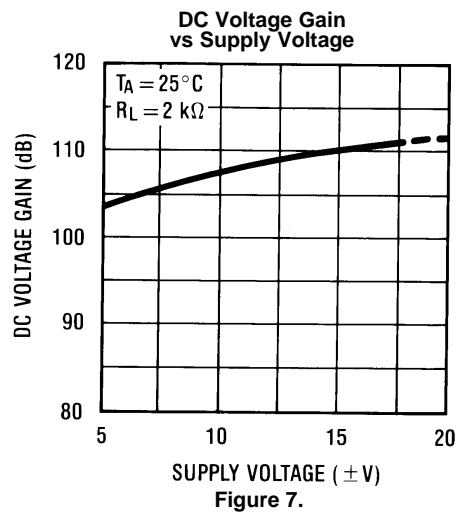
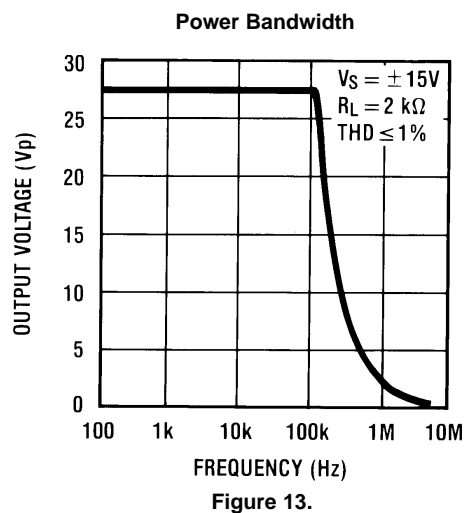
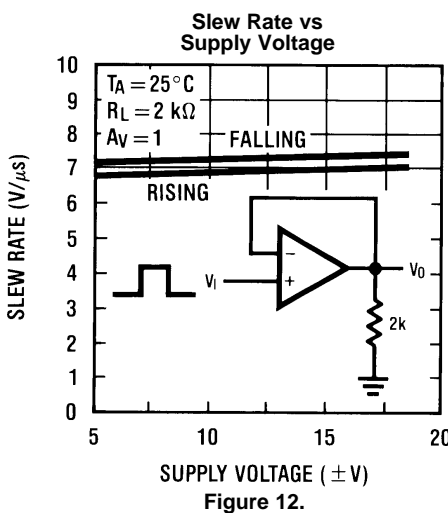
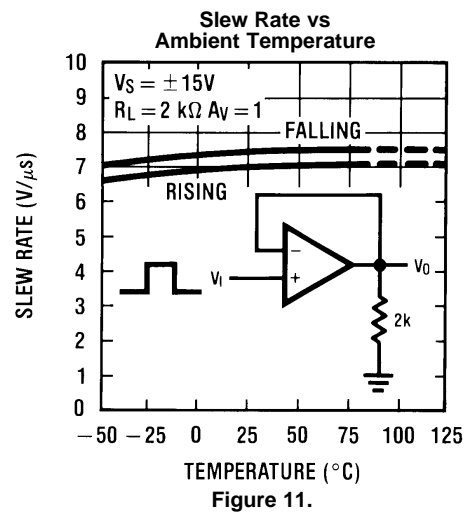
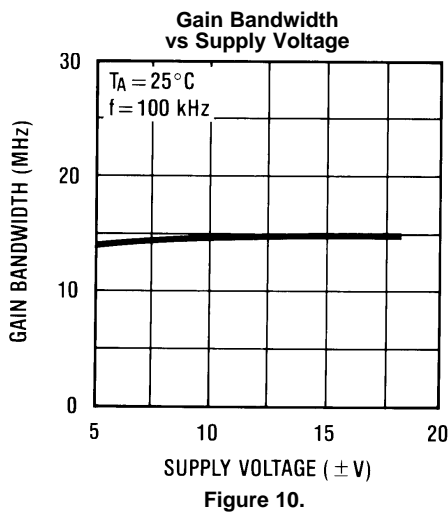
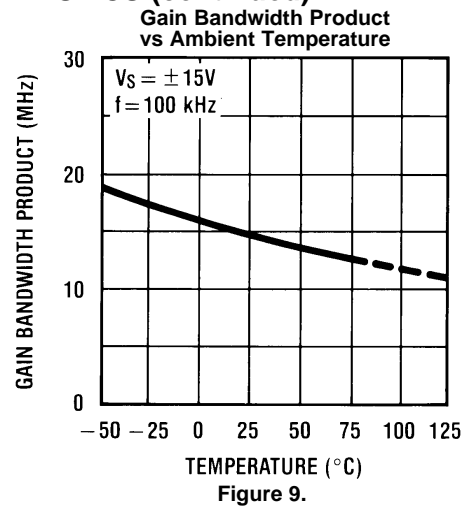
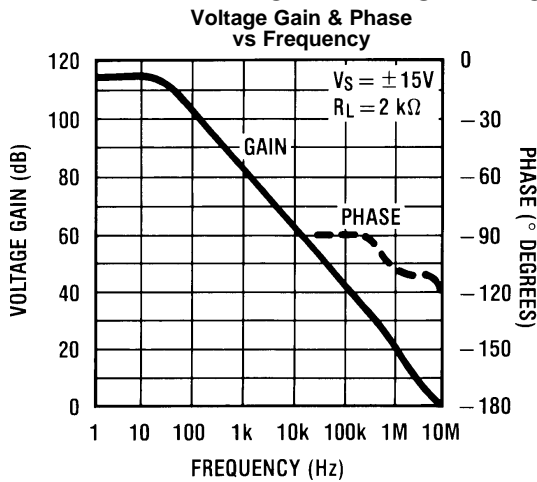
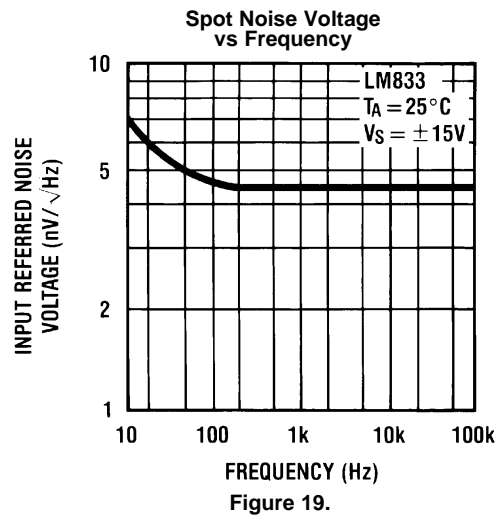
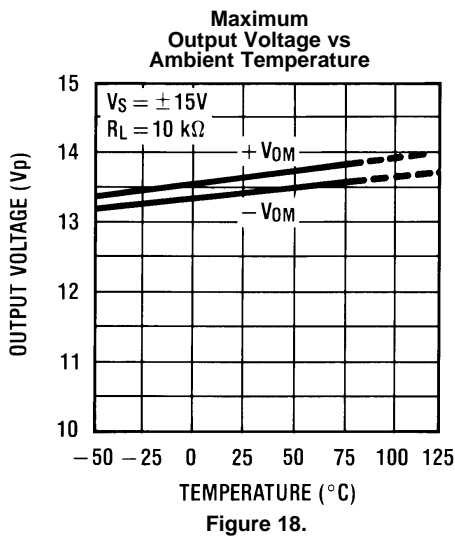
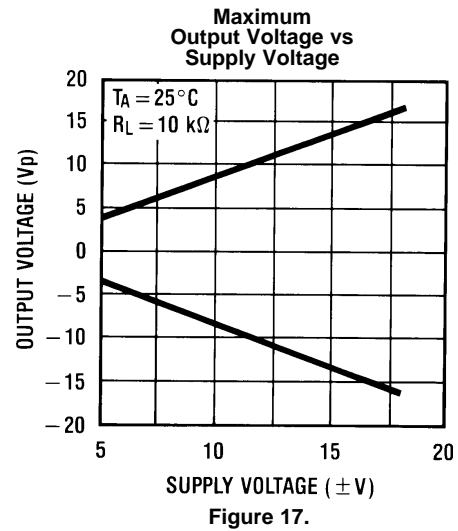
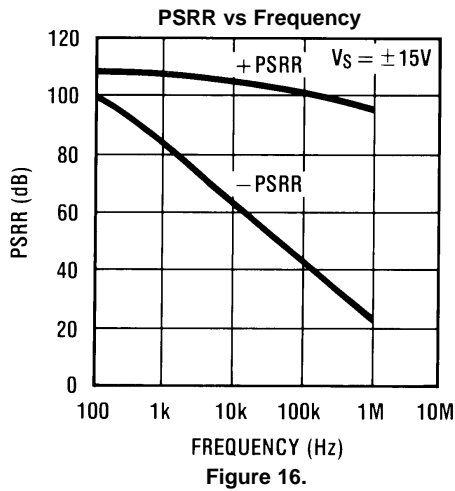
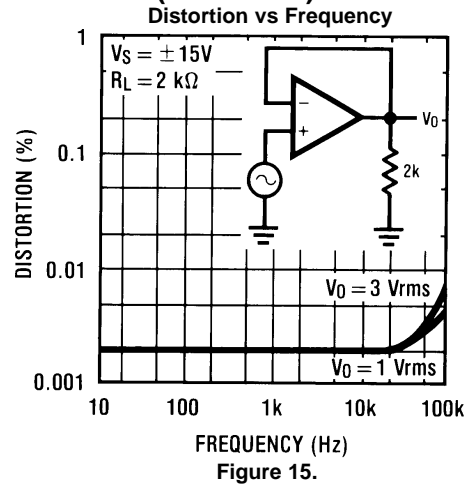
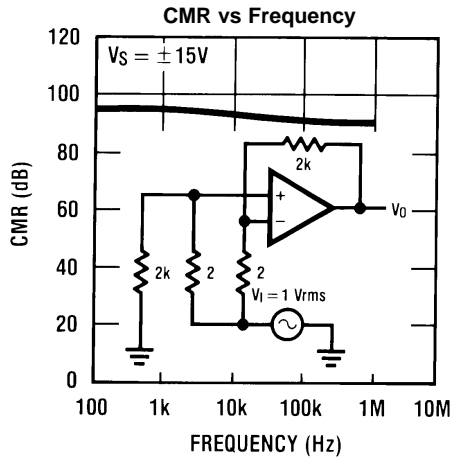


Figure 7.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)



TYPICAL PERFORMANCE CHARACTERISTICS (continued)



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

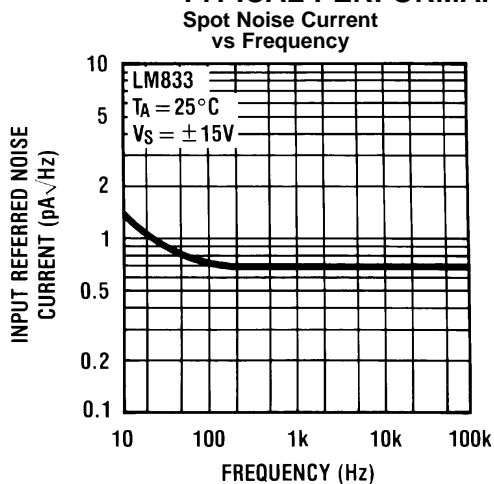


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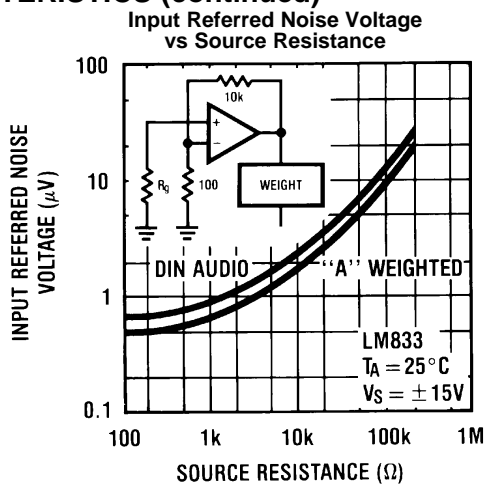
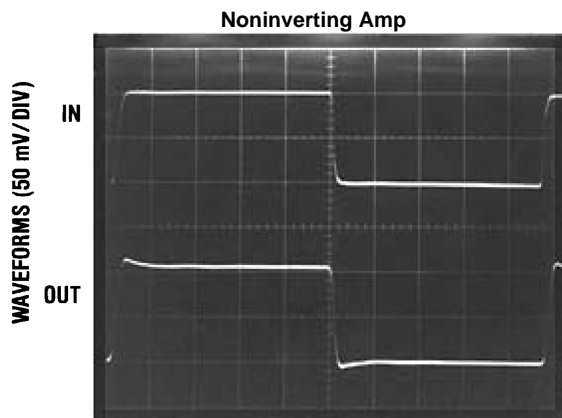
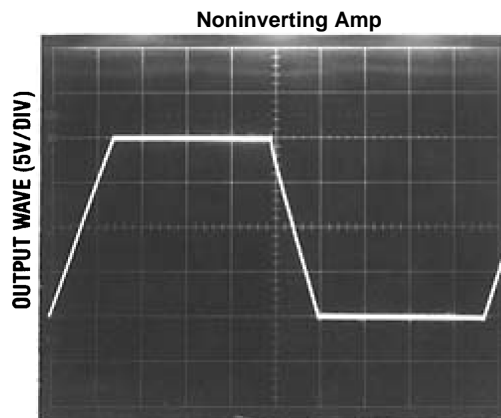


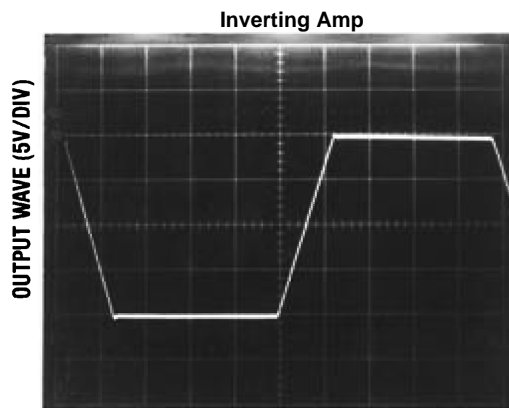
Figure 21.



TIME (0.2 μ s/DIV)
Figure 22.



TIME (2 μ s/DIV)
Figure 23.



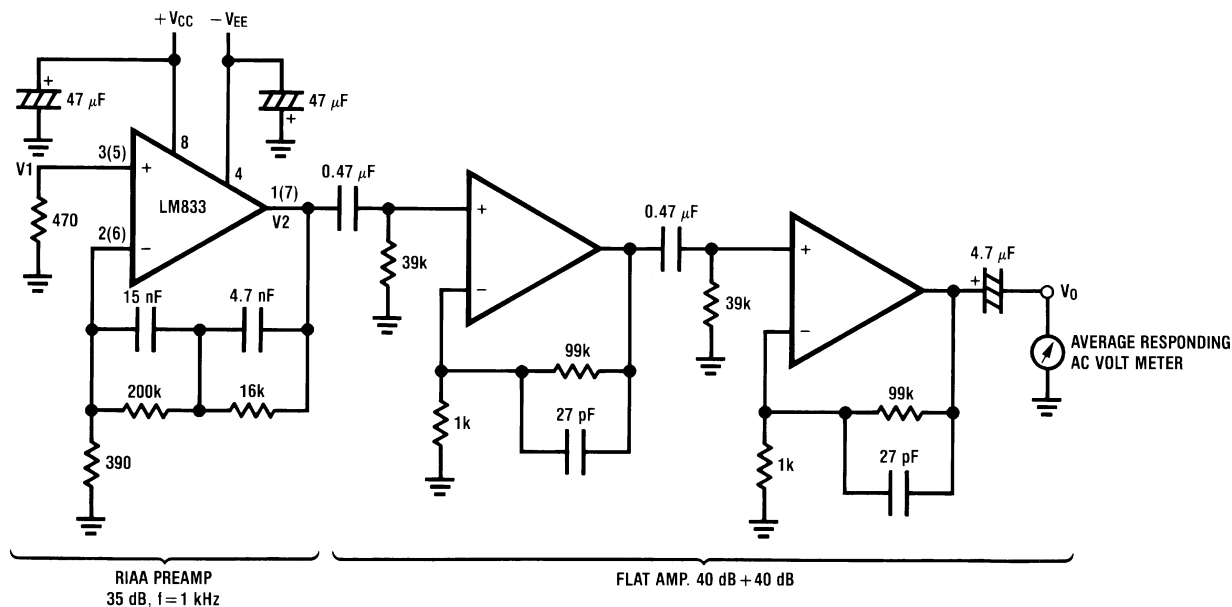
TIME (2 μ s/DIV)
Figure 24.

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

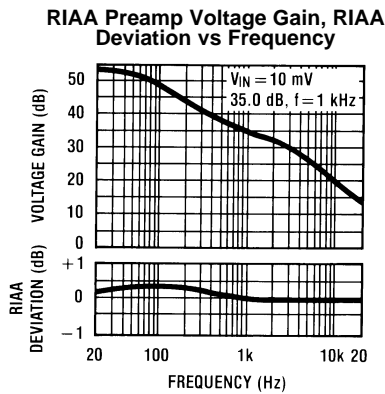
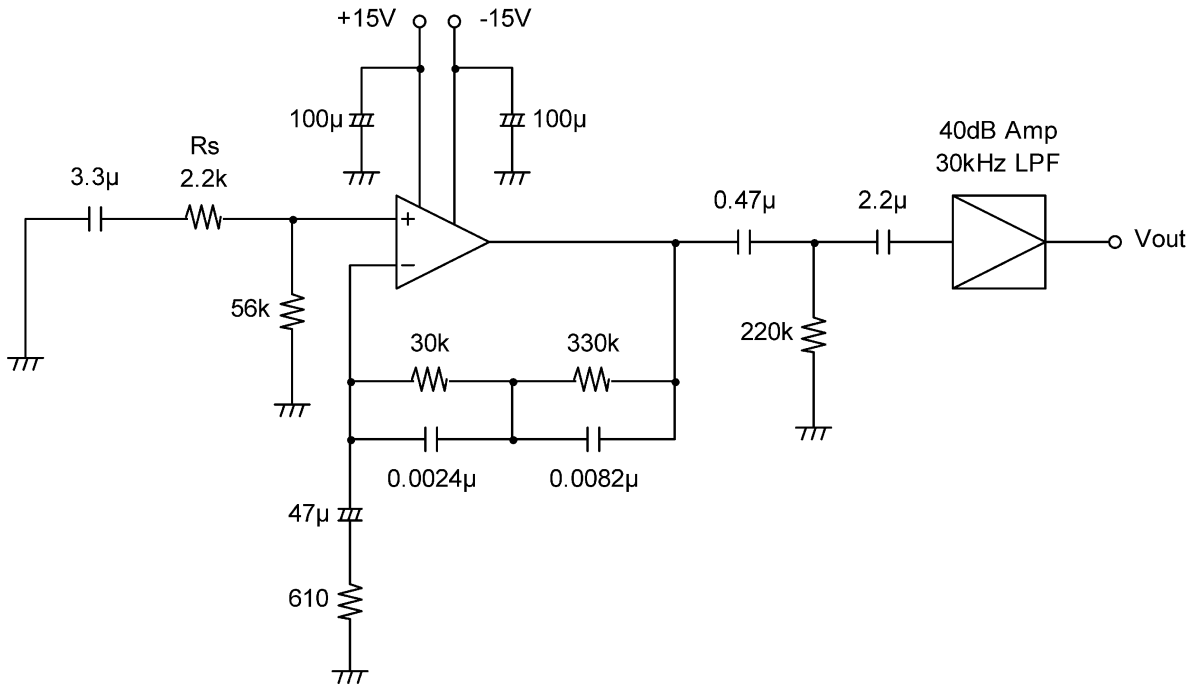


Figure 26.

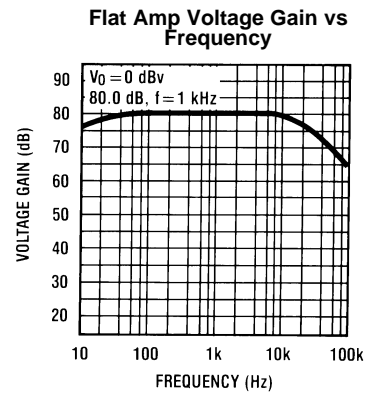
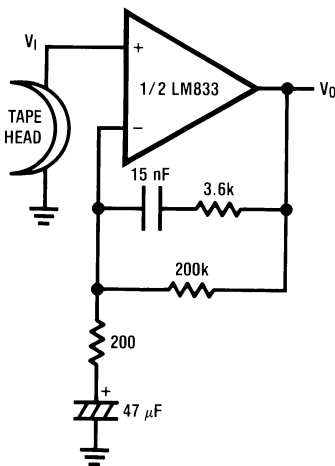


Figure 27.

Typical Applications



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

Figure 28. NAB Preamp

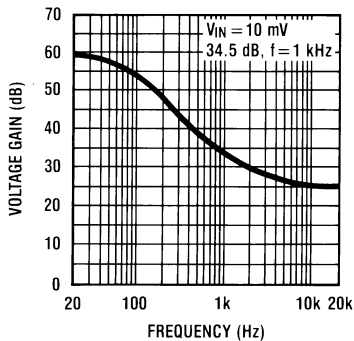
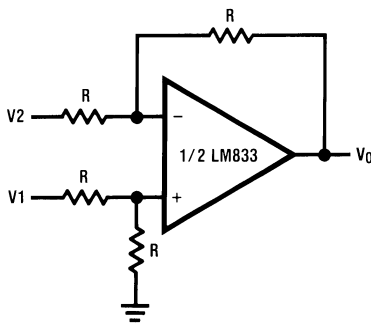
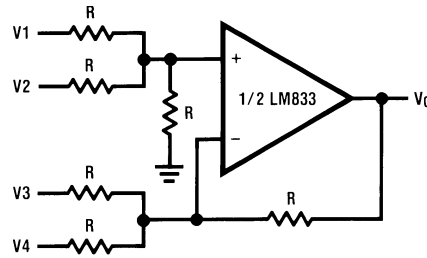


Figure 29. NAB Preamp Voltage Gain vs Frequency



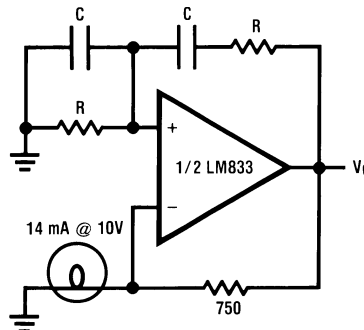
$V_O = V1 - V2$

Figure 30. Balanced to Single Ended Converter



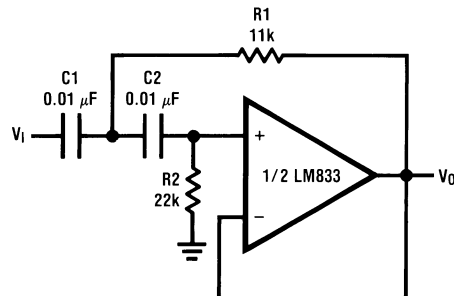
$$V_O = V_1 + V_2 - V_3 - V_4$$

Figure 31. Adder/Subtracter



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

Figure 32. Sine Wave Oscillator



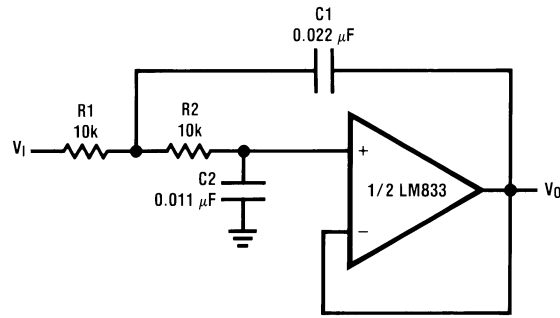
if $C_1 = C_2 = C$

$$R_1 = \frac{\sqrt{2}}{2\omega_0 C}$$

$$R_2 = 2 \cdot R_1$$

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

Figure 33. Second Order High Pass Filter (Butterworth)



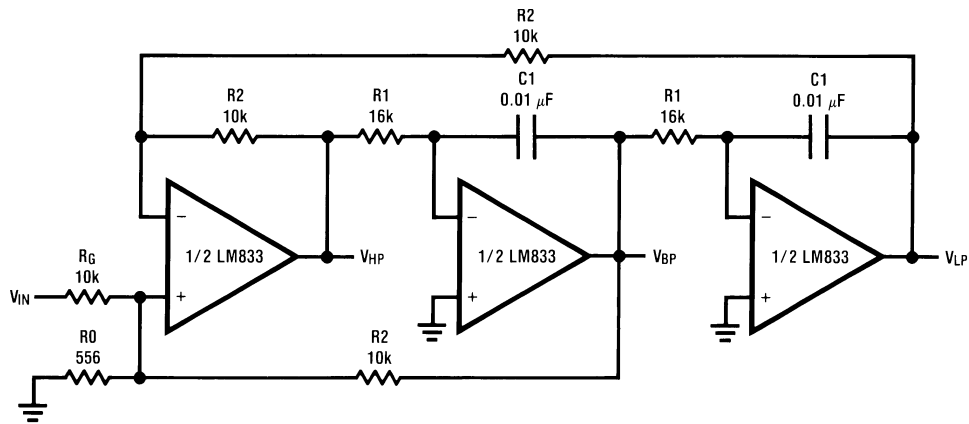
if $R1 = R2 = R$

$$C1 = \frac{\sqrt{2}}{\omega_0 R}$$

$$C2 = \frac{C1}{2}$$

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

Figure 34. Second Order Low Pass Filter (Butterworth)



$$f_0 = \frac{1}{2\pi C1 R1}, Q = \frac{1}{2} \left(1 + \frac{R2}{R0} + \frac{R2}{RG} \right), A_{BP} = QA_{LP} = QA_{LH} = \frac{R2}{RG}$$

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

Figure 35. State Variable Filter

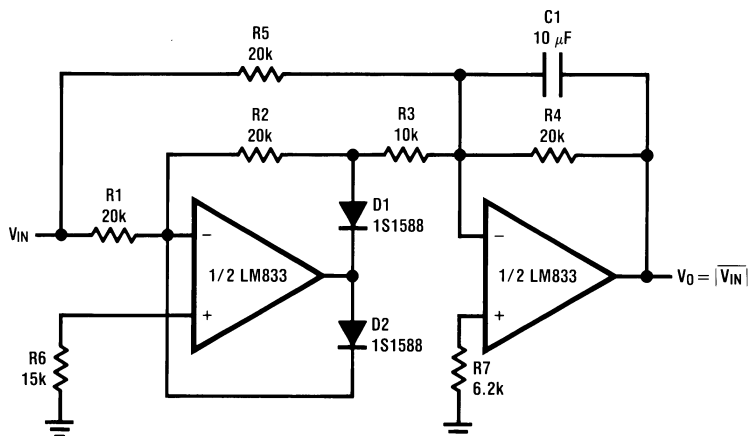


Figure 36. AC/DC Converter

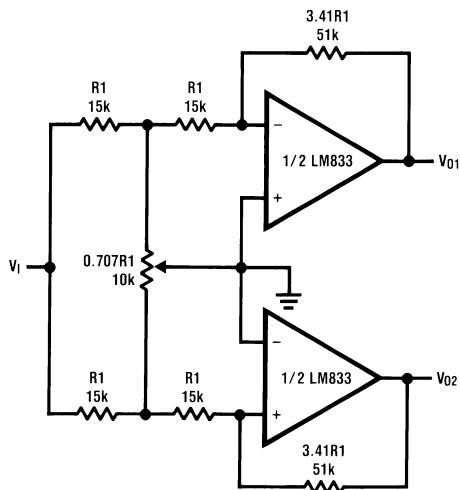


Figure 37. 2 Channel Panning Circuit (Pan Pot)

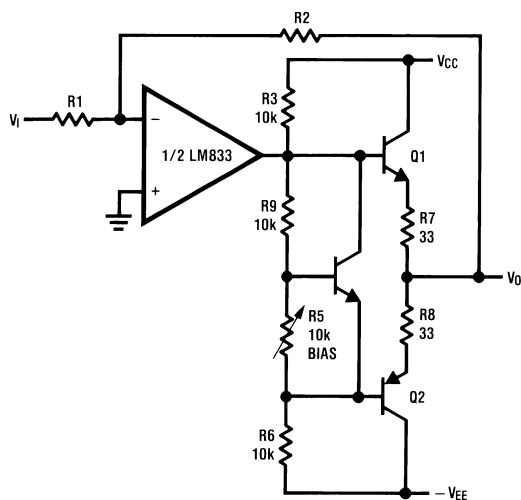
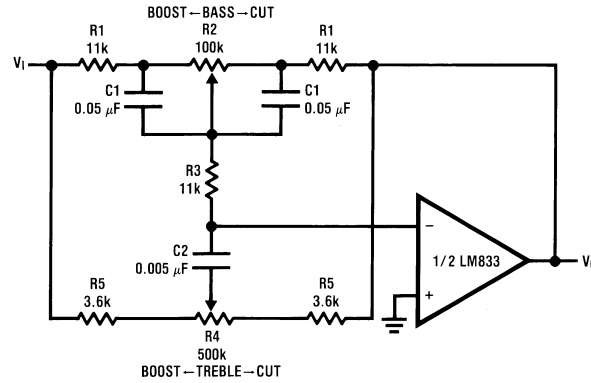


Figure 38. Line Driver



$$f_L = \frac{1}{2\pi R_2 C_1}, f_{LB} = \frac{1}{2\pi R_1 C_1}$$

$$f_H = \frac{1}{2\pi R_5 C_2}, f_{HB} = \frac{1}{2\pi (R_1 + R_5 + 2R_3) C_2}$$

Illustration is:

$f_L = 32 \text{ Hz}$, $f_{LB} = 320 \text{ Hz}$
 $f_H = 11 \text{ kHz}$, $f_{HB} = 1.1 \text{ kHz}$

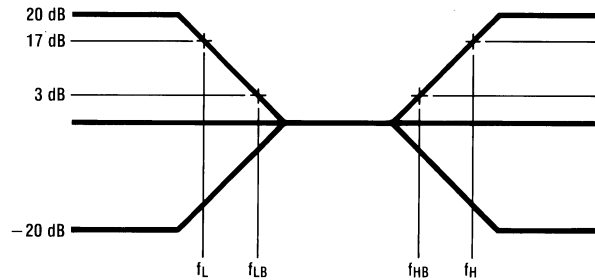
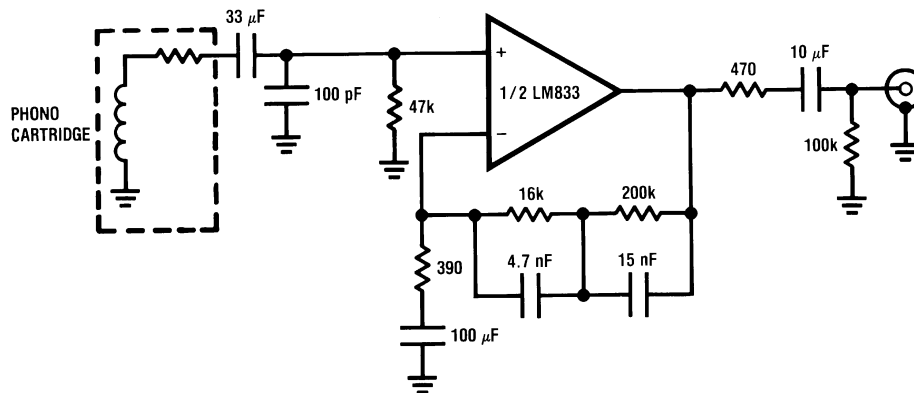
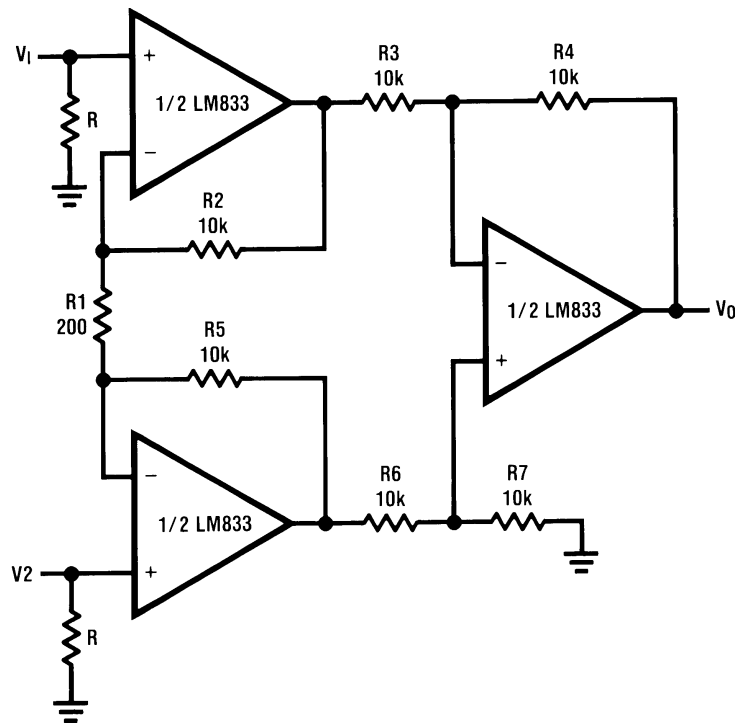


Figure 39. Tone Control



$A_v = 35 \text{ dB}$
 $E_n = 0.33 \mu\text{V}$
 $S/N = 90 \text{ dB}$
 $f = 1 \text{ kHz}$
 A Weighted
 A Weighted, $V_{IN} = 10 \text{ mV}$
 @ $f = 1 \text{ kHz}$

Figure 40. RIAA Preamp



If $R_2 = R_5$, $R_3 = R_6$, $R_4 = R_7$

$$V_0 = \left(1 + \frac{2R_2}{R_1}\right) \frac{R_4}{R_3} (V_2 - V_1)$$

Illustration is:
 $V_0 = 101(V_2 - V_1)$

Figure 41. Balanced Input Mic Amp

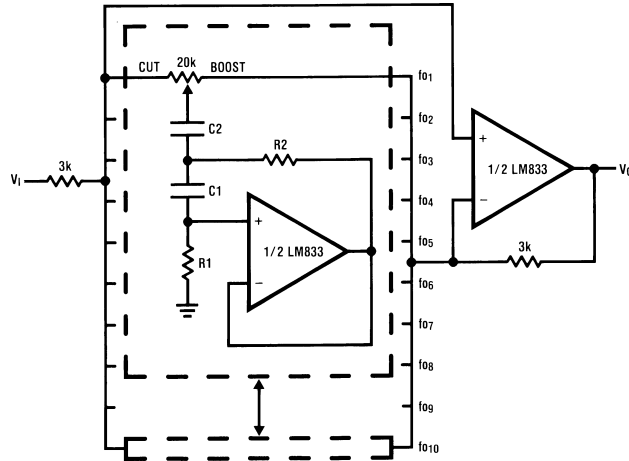


Figure 42. 10 Band Graphic Equalizer

| fo (Hz) | C ₁ | C ₂ | R ₁ | R ₂ |
|---------|----------------|----------------|----------------|----------------|
| 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

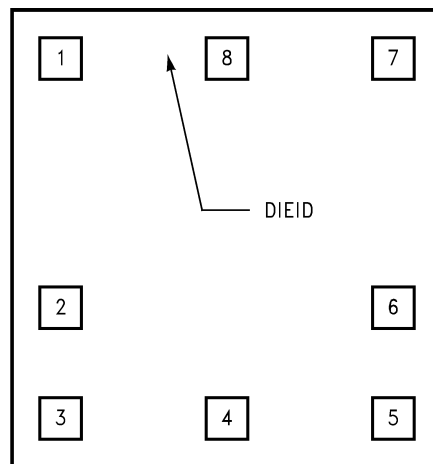


Figure 43. Die Layout (A - Step)

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM833M | ACTIVE | SOIC | D | 8 | 95 | TBD | Call TI | Call TI | -40 to 85 | LM833 M | Samples |
| LM833M/NOPB | ACTIVE | SOIC | D | 8 | 95 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -40 to 85 | LM833 M | Samples |
| LM833MM/NOPB | ACTIVE | VSSOP | DGK | 8 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -40 to 85 | Z83 | Samples |
| LM833MMX/NOPB | ACTIVE | VSSOP | DGK | 8 | 3500 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -40 to 85 | Z83 | Samples |
| LM833MX/NOPB | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -40 to 85 | LM833 M | Samples |
| LM833N/NOPB | ACTIVE | PDIP | P | 8 | 40 | Green (RoHS & no Sb/Br) | CU SN Call TI | Level-1-NA-UNLIM | -40 to 85 | LM 833N | Samples |

(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), Pb-Free (RoHS Exempt), 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.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

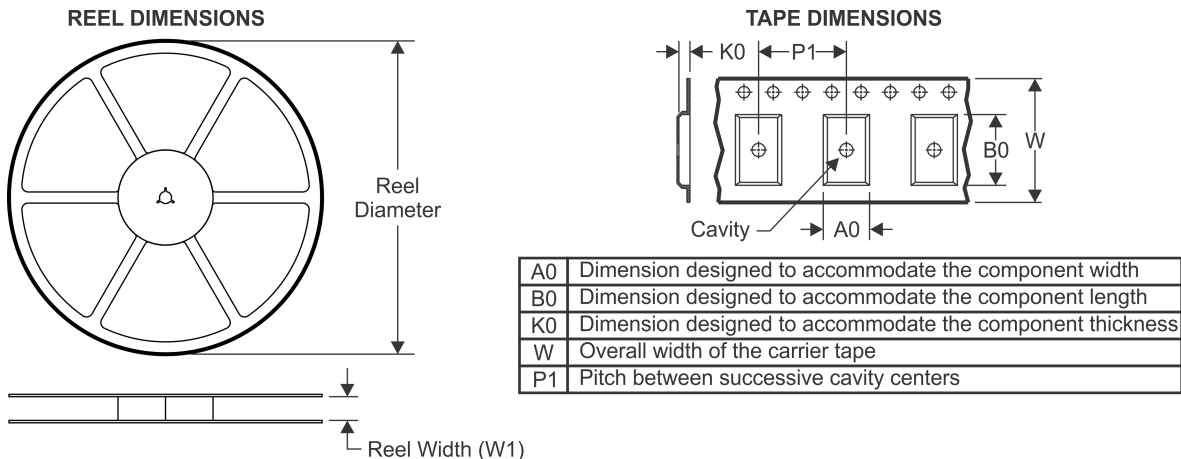
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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 | 210.0 | 185.0 | 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 |



D0008A

PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES:

- 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.
- This drawing is subject to change without notice.
- 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.
- This dimension does not include interlead flash.
- 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

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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

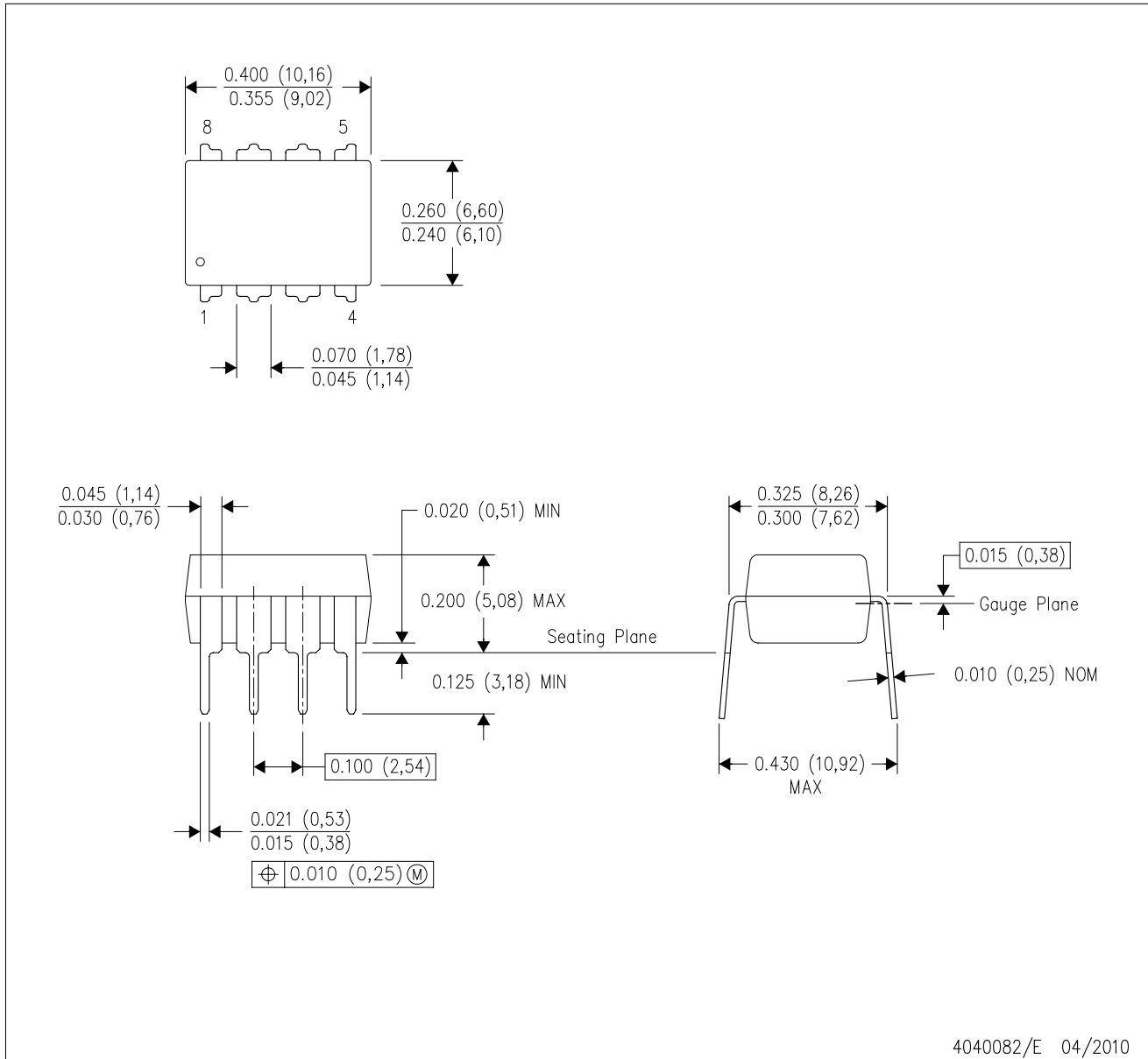
4214825/C 02/2019

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.



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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