

LM833 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 MSOP package

DESCRIPTION

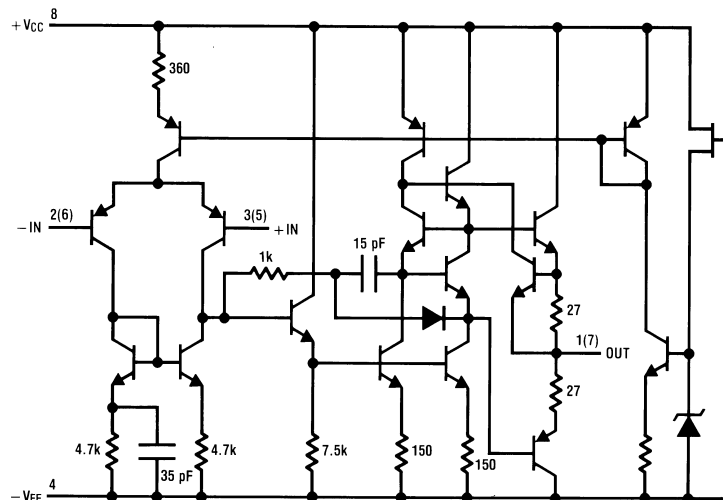
The LM833 is a dual general purpose operational amplifier designed with particular emphasis on performance in audio systems.

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

Schematic Diagram

(1/2 LM833)



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Connection Diagram

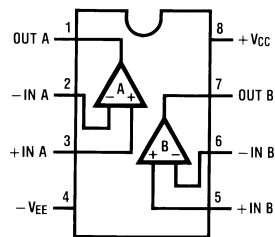


Figure 1.



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⁾

Supply Voltage $V_{CC}-V_{EE}$	36V
Differential Input Voltage ⁽²⁾ V_I	$\pm 30V$
Input Voltage Range ⁽²⁾ V_{IC}	$\pm 15V$
Power Dissipation ⁽³⁾ 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 Dual-In-Line Package Soldering (10 seconds)	260°C
Small Outline Package (SOIC and MSOP)	
Vapor Phase (60 seconds)	215°C
Infrared (15 seconds)	220°C
ESD tolerance ⁽⁴⁾	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 guarantee specific performance limits. *Electrical Characteristics* state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.
- (2) If supply voltage is less than $\pm 15V$, it is equal to supply voltage.
- (3) This is the permissible value at $T_A \leq 85^{\circ}C$.
- (4) 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 guarantee specific performance limits. *Electrical Characteristics* state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed 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

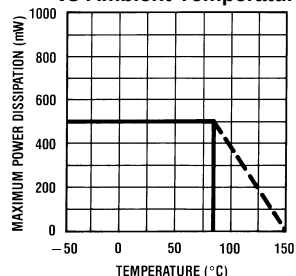
($T_A = 25^\circ\text{C}$, $V_S = \pm 15\text{V}$)

The following parameters are not tested or guaranteed.

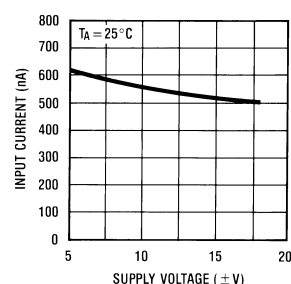
Symbol	Parameter	Conditions	Typ	Units
$\Delta V_{OS}/\Delta T$	Average Temperature Coefficient of Input Offset Voltage		2	$\mu\text{V}/^\circ\text{C}$
THD	Distortion	$R_L = 2\text{ k}\Omega$, $f = 20\sim 20\text{ kHz}$ $V_{OUT} = 3\text{ V}_{rms}$, $A_V = 1$	0.002	%
e_n	Input Referred Noise Voltage	$R_S = 100\Omega$, $f = 1\text{ kHz}$	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	$V_O = 27\text{ V}_{pp}$, $R_L = 2\text{ k}\Omega$, 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

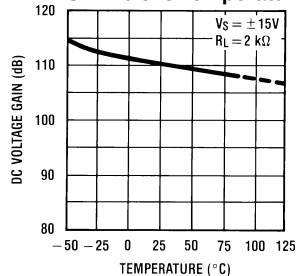
Maximum Power Dissipation vs Ambient Temperature



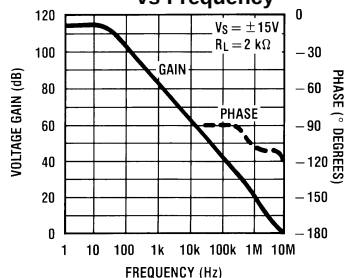
Input Bias Current vs Supply Voltage



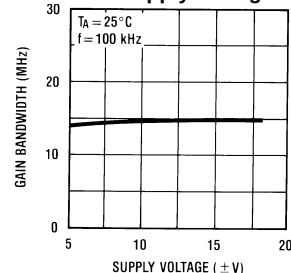
DC Voltage Gain vs Ambient Temperature



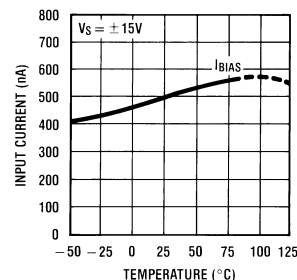
Voltage Gain & Phase vs Frequency



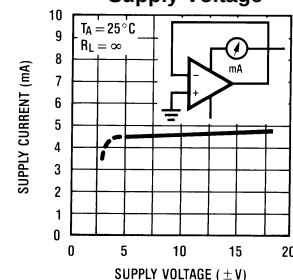
Gain Bandwidth vs Supply Voltage



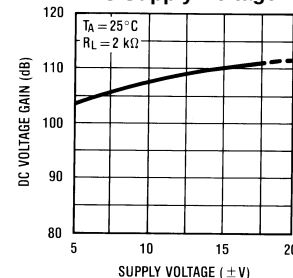
Input Bias Current vs Ambient Temperature



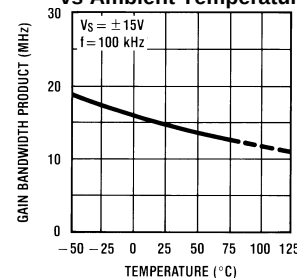
Supply Current vs Supply Voltage



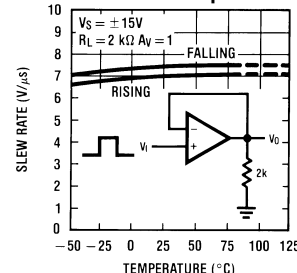
DC Voltage Gain vs Supply Voltage



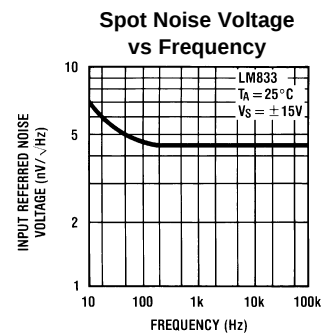
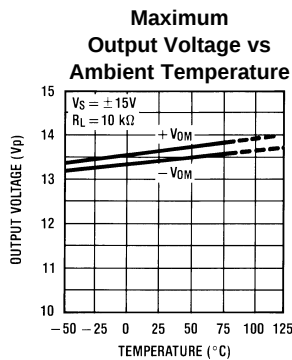
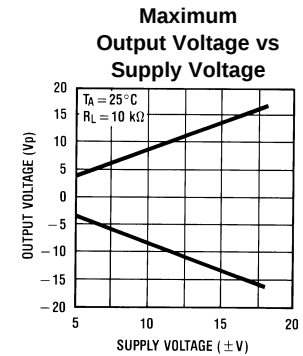
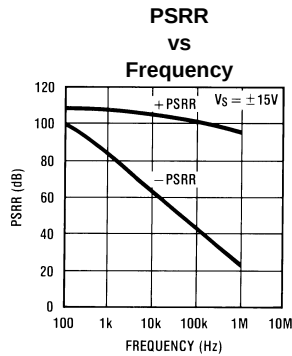
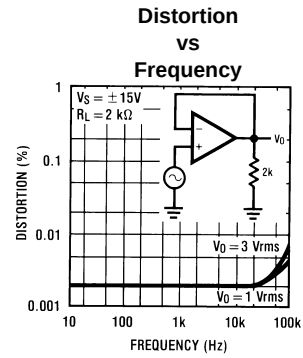
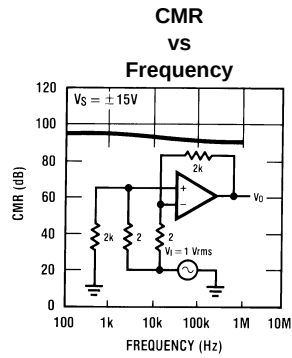
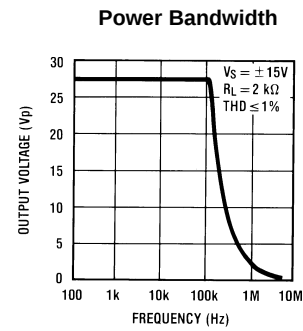
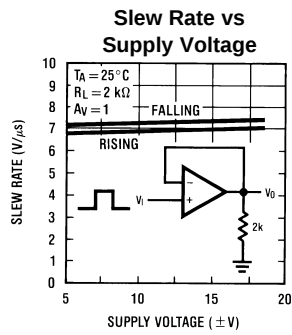
Gain Bandwidth Product vs Ambient Temperature



Slew Rate vs Ambient Temperature

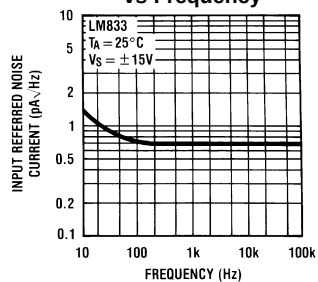


Typical Performance Characteristics (continued)

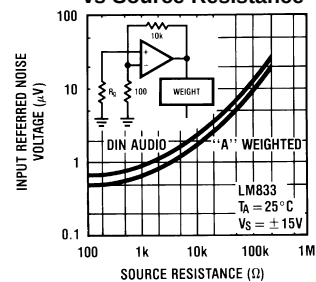


Typical Performance Characteristics (continued)

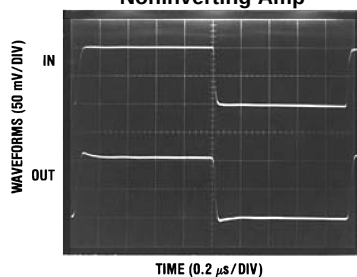
**Spot Noise Current
vs Frequency**



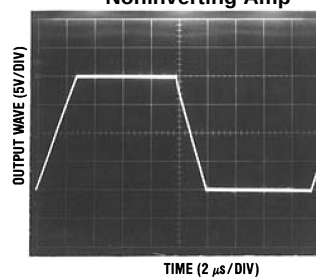
**Input Referred Noise Voltage
vs Source Resistance**



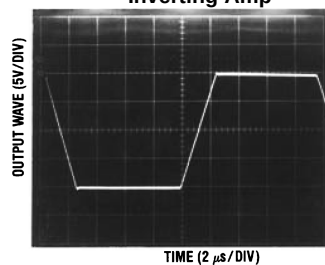
Noninverting Amp



Noninverting Amp



Inverting Amp

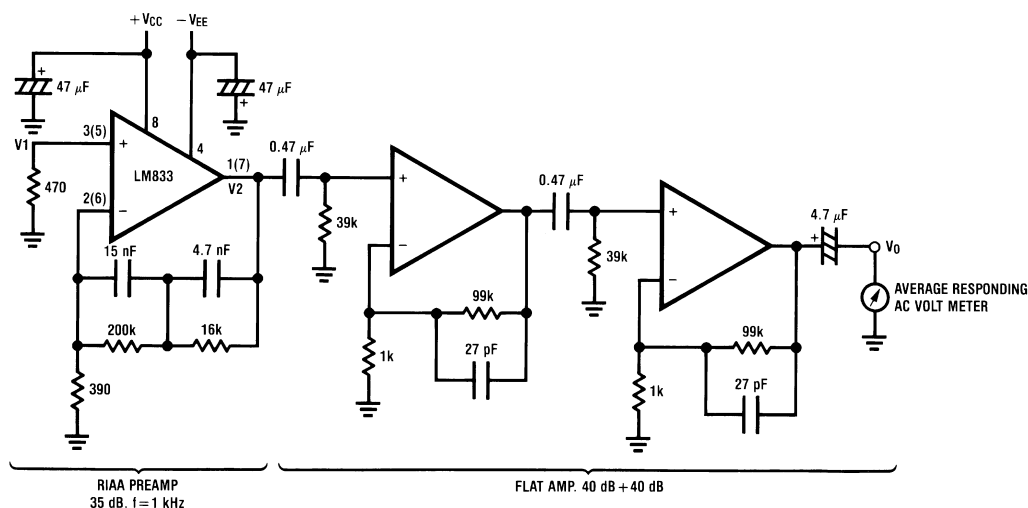


Application Hints

The LM833 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.

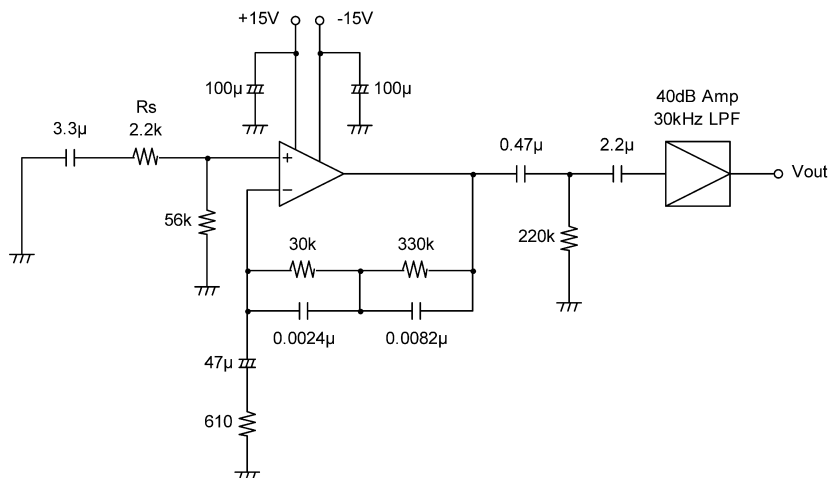
Noise Measurement Circuit



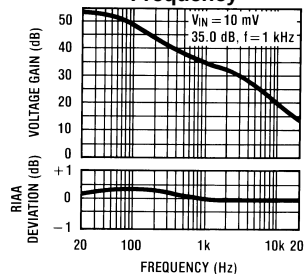
Complete shielding is required to prevent induced pick up from external sources. Always check with oscilloscope for power line noise.

Figure 2. Total Gain: 115 dB @f = 1 kHz
Input Referred Noise Voltage: $e_n = V_0/560,000$ (V)

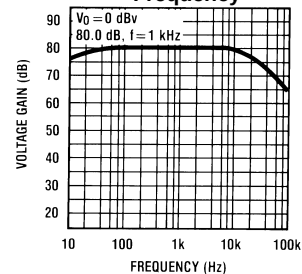
RIAA Noise Voltage Measurement Circuit



**RIAA Preamp Voltage Gain, RIAA
Deviation
vs
Frequency**

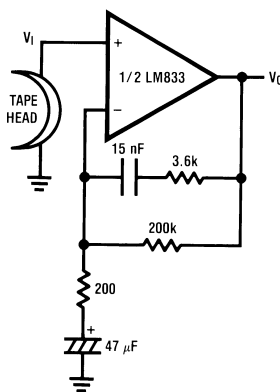


**Flat Amp Voltage Gain vs
Frequency**



Typical Applications

Figure 3. NAB Preamp



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

**Figure 4. NAB Preamp Voltage Gain
vs Frequency**

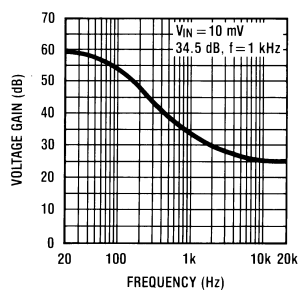
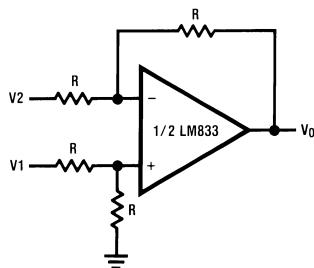
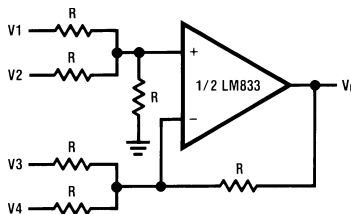


Figure 5. Balanced to Single Ended Converter



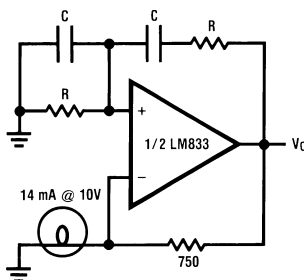
$$V_O = V_1 - V_2$$

Figure 6. Adder/Subtractor



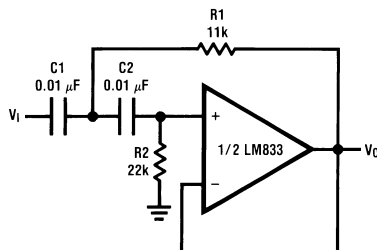
$$V_O = V_1 + V_2 - V_3 - V_4$$

Figure 7. Sine Wave Oscillator



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

Figure 8. Second Order High Pass Filter (Butterworth)

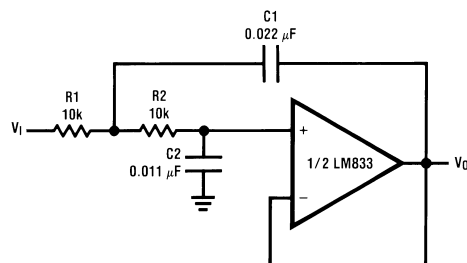


$$\text{if } C_1 = C_2 = C$$

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

$$R_2 = 2 \cdot R_1$$

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

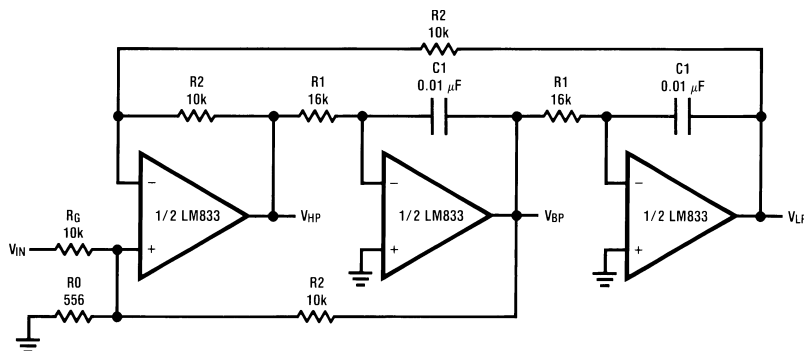
Figure 9. Second Order Low Pass Filter (Butterworth)

if $R_1 = R_2 = R$

$$C_1 = \frac{\sqrt{2}}{\omega_0 R}$$

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

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

Figure 10. State Variable Filter

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

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

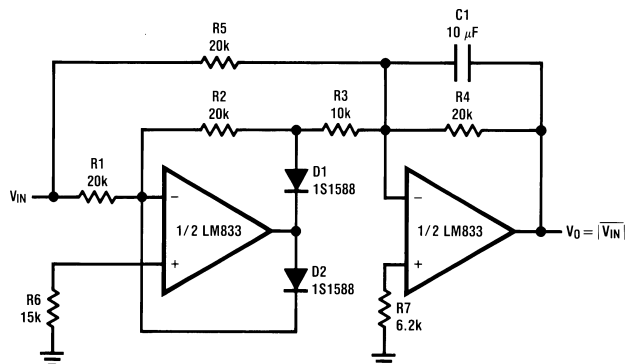
Figure 11. AC/DC Converter

Figure 12. 2 Channel Panning Circuit (Pan Pot)

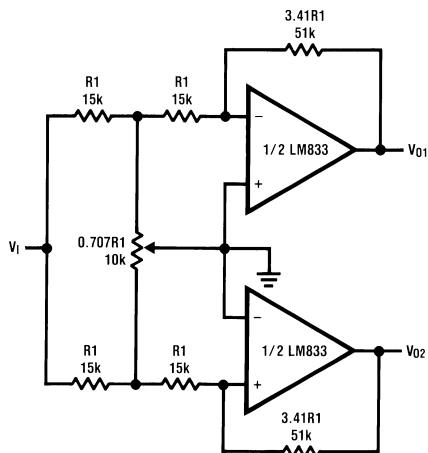


Figure 13. Line Driver

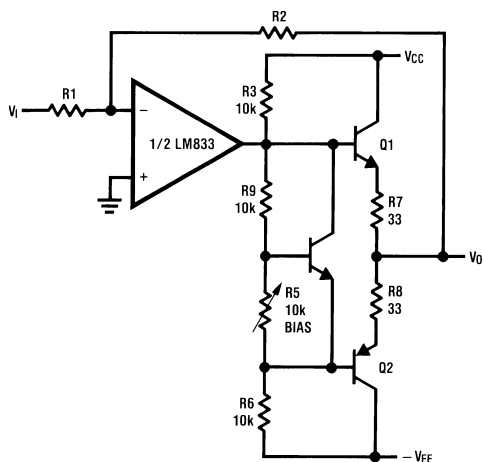
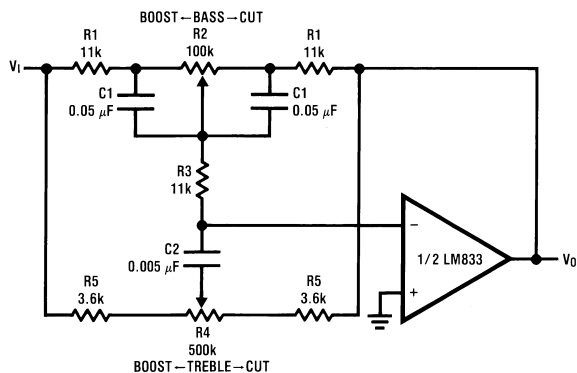


Figure 14. Tone Control



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

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

Illustration is:

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

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

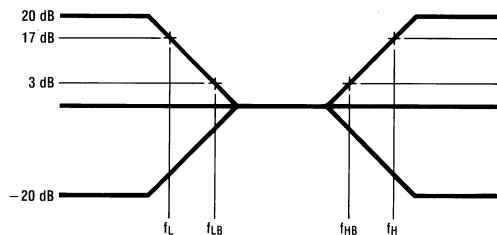
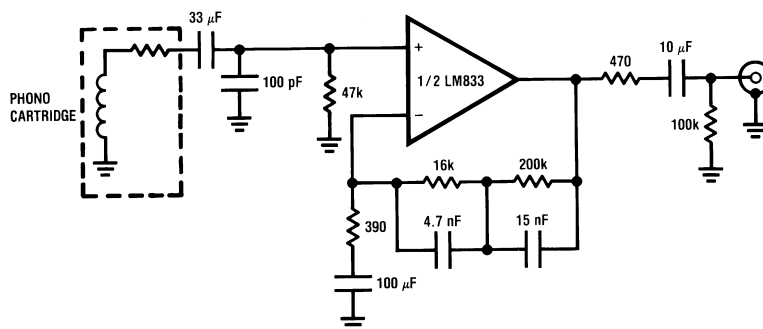
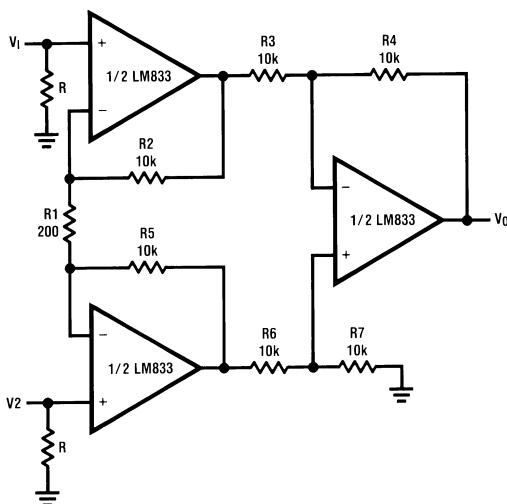


Figure 15. RIAA Preamp



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

Figure 16. Balanced Input Mic Amp



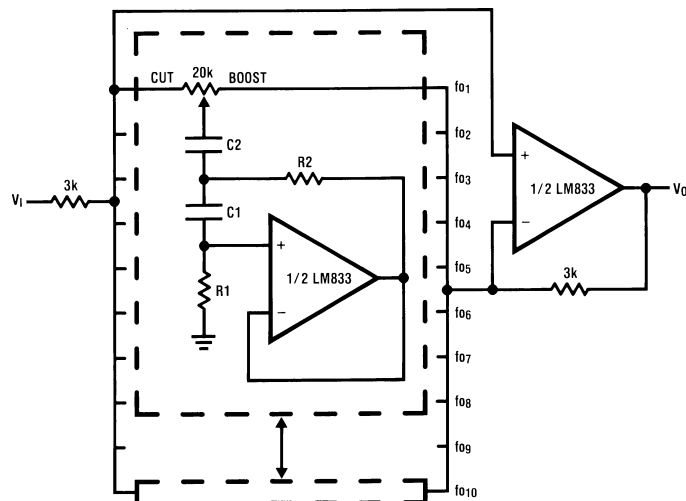
If $R_2 = R_5$, $R_3 = R_6$, $R_4 = R_7$

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

Illustration is:

$$V_0 = 101(V_2 - V_1)$$

Figure 17. 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

**LM833 MDC MWC
DUAL AUDIO OPERATIONAL AMPLIFIER**

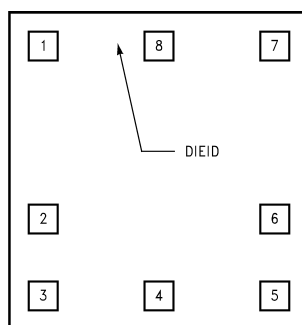


Figure 18. Die Layout (A - Step)

Table 1. Die/Wafer Characteristics

Fabrication Attributes		General Die Information	
Physical Die Identification	LM833A	Bond Pad Opening Size (min)	110μm x 110μm
Die Step	A	Bond Pad Metalization	ALUMINUM
Physical Attributes		Passivation	VOM NITRIDE
Wafer Diameter	150mm	Back Side Metal	BARE BACK
Dise Size (Drawn)	1219μm x 1270μm 48mils x 50mils	Back Side Connection	Floating
Thickness	406μm Nominal		
Min Pitch	288μm Nominal		

Special Assembly Requirements:**Note:** Actual die size is rounded to the nearest micron.**Die Bond Pad Coordinate Locations (A - Step)**

(Referenced to die center, coordinates in μm) NC = No Connection

SIGNAL NAME	PAD NUMBER	X/Y COORDINATES		PAD SIZE		
		X	Y	X		Y
OUTPUT A	1	-476	500	110	x	110
INPUT A-	2	-476	-212	110	x	110
INPUT A+	3	-476	-500	110	x	110
VEE-	4	-0	-500	110	x	110
INPUT B+	5	476	-500	110	x	110
INPUT B-	6	476	-212	110	x	110
OUTPUT B	7	476	500	110	x	110
VCC+	8	0	500	110	x	110

IN U.S.A

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IN EUROPE

Tel: 49 (0) 8141 351492 / 1495

Fax: 49 (0) 8141 351470

IN ASIA PACIFIC

Tel: (852) 27371701

IN JAPAN

Tel: 81 043 299 2308

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM833M	ACTIVE	SOIC	D	8	95	TBD	CU SNPB	Level-1-235C-UNLIM	-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	ACTIVE	VSSOP	DGK	8	1000	TBD	CU SNPB	Level-1-260C-UNLIM	-40 to 85	Z83	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	ACTIVE	SOIC	D	8	2500	TBD	CU SNPB	Level-1-235C-UNLIM	-40 to 85	LM833 M	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	ACTIVE	PDIP	P	8	40	TBD	SNPB	Level-1-NA-UNLIM	-40 to 85	LM 833N	Samples
LM833N/NOPB	ACTIVE	PDIP	P	8	40	Green (RoHS & no Sb/Br)	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⁾ Only one of markings shown within the brackets will appear on the physical device.

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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	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
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	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	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	VSSOP	DGK	8	1000	203.0	190.0	41.0
LM833MM/NOPB	VSSOP	DGK	8	1000	203.0	190.0	41.0
LM833MMX/NOPB	VSSOP	DGK	8	3500	349.0	337.0	45.0
LM833MX	SOIC	D	8	2500	349.0	337.0	45.0
LM833MX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0

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.

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
 - E. Falls within JEDEC MO-187 variation AA, except interlead flash.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - $\triangle D$ Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AA.

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