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تهران پاساژ امجد طبقه 1 واحد 16



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## Dual Audio Operational Amplifier

### General 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.

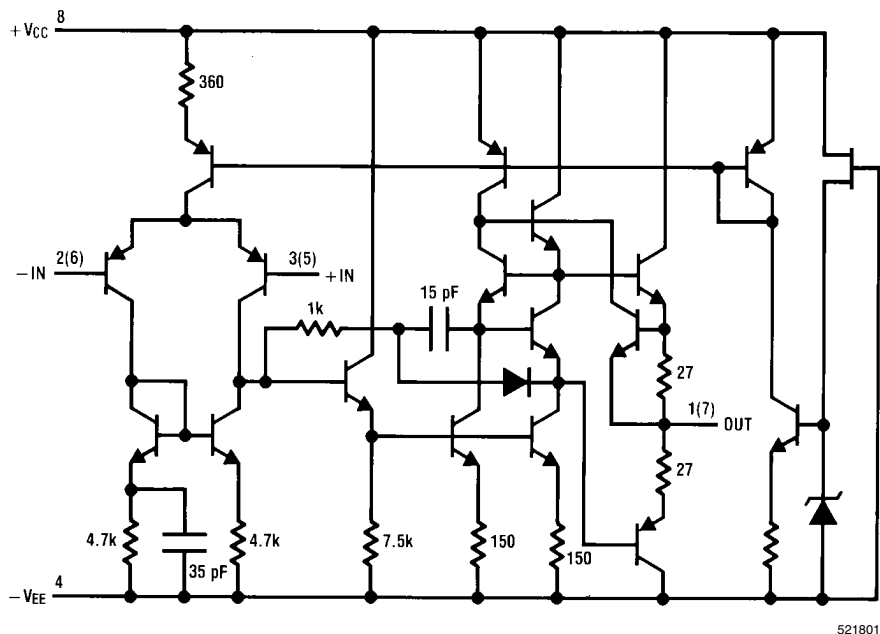
The LM833 is pin-for-pin compatible with industry standard dual operational amplifiers.

### Features

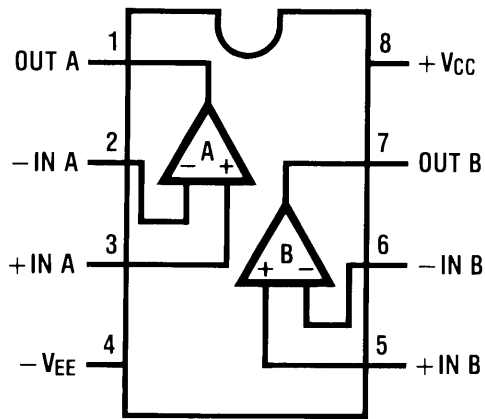
- Wide dynamic range: >140dB
- Low input noise voltage:  $4.5\text{nV}/\sqrt{\text{Hz}}$
- High slew rate:  $7\text{ V}/\mu\text{s}$  (typ);  $5\text{ V}/\mu\text{s}$  (min)
- High gain bandwidth:  $15\text{MHz}$  (typ);  $10\text{MHz}$  (min)
- Wide power bandwidth:  $120\text{KHz}$
- Low distortion:  $0.002\%$
- Low offset voltage:  $0.3\text{mV}$
- Large phase margin:  $60^\circ$
- Available in 8 pin MSOP package

### Schematic Diagram

(1/2 LM833)



## Connection Diagram



Order Number LM833M, LM833MX, LM833AM, LM833AMX, LM833N, LM833MM or LM833MMX  
See NS Package Number  
M08A, N08E or MUA08A

521802

## Absolute Maximum Ratings *(Note 1)*

If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.

Supply Voltage $V_{CC}-V_{EE}$	36V
Differential Input Voltage <i>(Note 3)</i> $V_I$	$\pm 30V$
Input Voltage Range <i>(Note 3)</i> $V_{IC}$	$\pm 15V$
Power Dissipation <i>(Note 4)</i> $P_D$	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 <i>(Note 5)</i>	1600V

## DC Electrical Characteristics *(Note 1, Note 2)*

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

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	$R_L = 2\text{ k}\Omega$ , $V_O = \pm 10V$	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	$V_{IN} = \pm 12V$	80	100		dB
PSRR	Power Supply Rejection Ratio	$V_S = 15 \sim 5V$ , $-15 \sim -5V$	80	100		dB
$I_Q$	Supply Current	$V_O = 0V$ , Both Amps		5	8	mA

## AC Electrical Characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
SR	Slew Rate	$R_L = 2\text{ k}\Omega$	5	7		V/ $\mu s$
GBW	Gain Bandwidth Product	$f = 100\text{ kHz}$	10	15		MHz
$V_{NI}$	Equivalent Input Noise Voltage (LM833AM, LM833AMX)	RIAA, $R_S = 2.2\text{ k}\Omega$ <i>(Note 6)</i>			1.4	$\mu V$

## Design Electrical Characteristics

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

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	$\mu V/^\circ C$
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	$nV/\sqrt{Hz}$

Symbol	Parameter	Conditions	Typ	Units
$i_n$	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
$\phi_M$	Phase Margin	Open Loop	60	deg
	Input Referred Cross Talk	$f = 20 \sim 20 \text{ kHz}$	-120	dB

**Note 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.

**Note 2:** All voltages are measured with respect to the ground pin, unless otherwise specified.

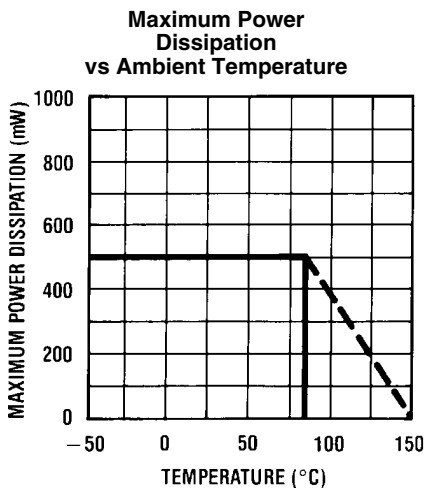
**Note 3:** If supply voltage is less than  $\pm 15V$ , it is equal to supply voltage.

**Note 4:** This is the permissible value at  $T_A \leq 85^\circ C$ .

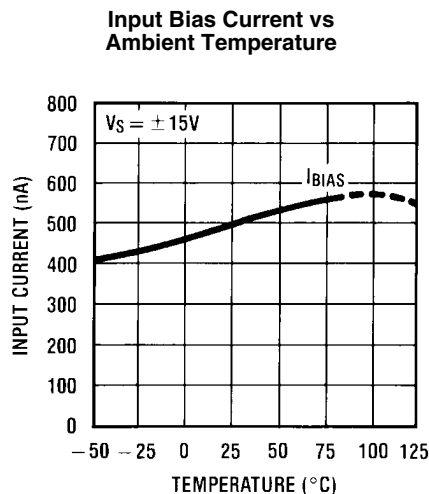
**Note 5:** Human body model, 1.5 k $\Omega$  in series with 100 pF.

**Note 6:** RIAA Noise Voltage Measurement Circuit

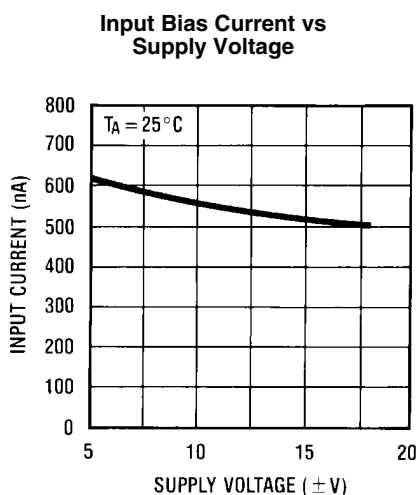
## Typical Performance Characteristics



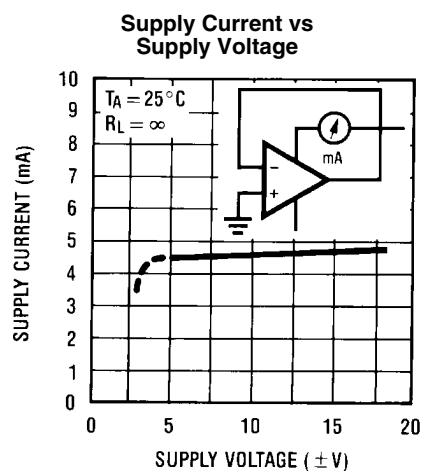
521804



521805

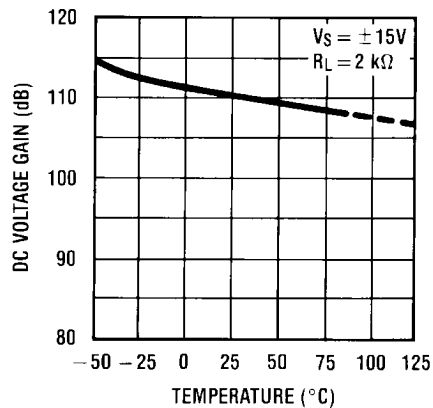


521806



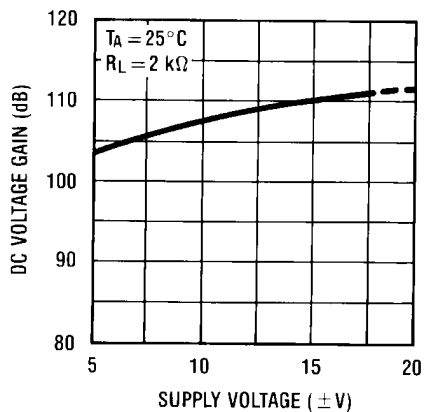
521807

**DC Voltage Gain vs Ambient Temperature**



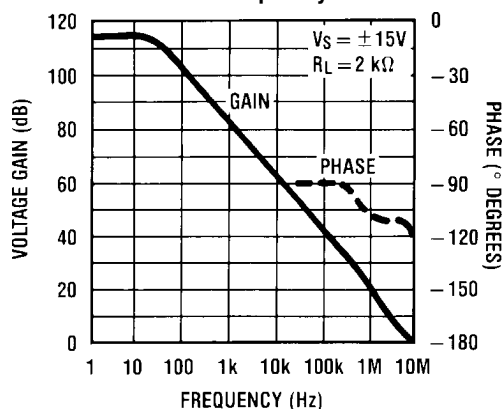
521808

**DC Voltage Gain vs Supply Voltage**



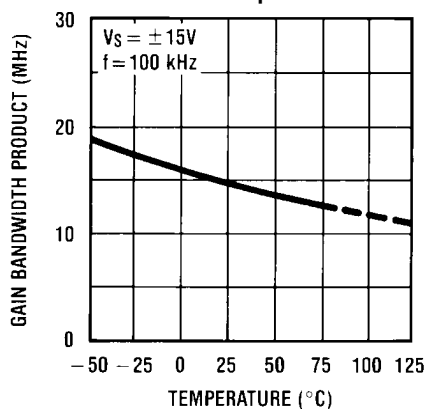
521809

**Voltage Gain & Phase vs Frequency**



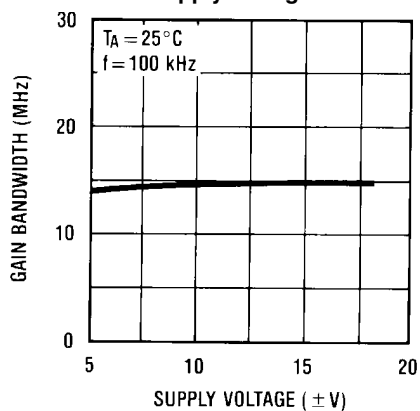
521810

**Gain Bandwidth Product vs Ambient Temperature**



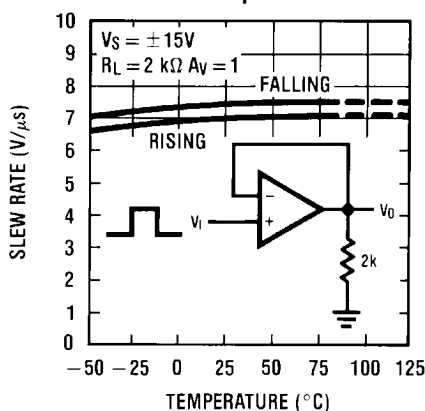
521811

**Gain Bandwidth vs Supply Voltage**

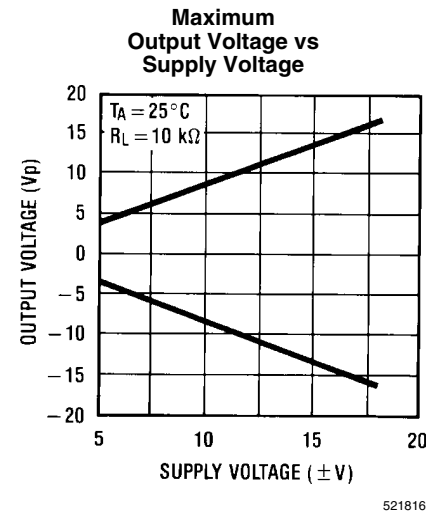
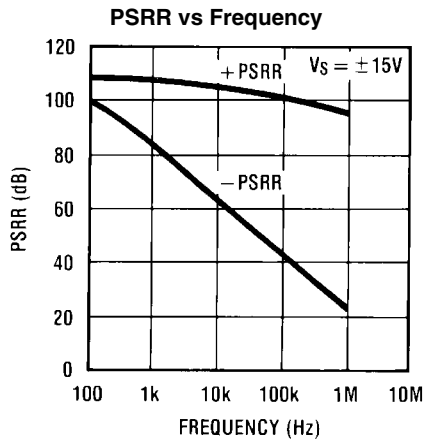
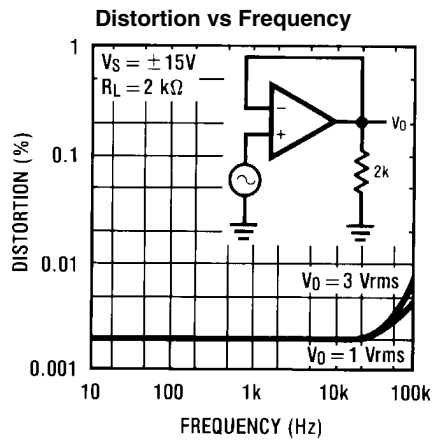
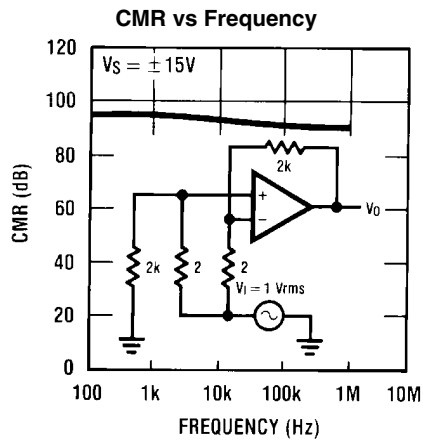
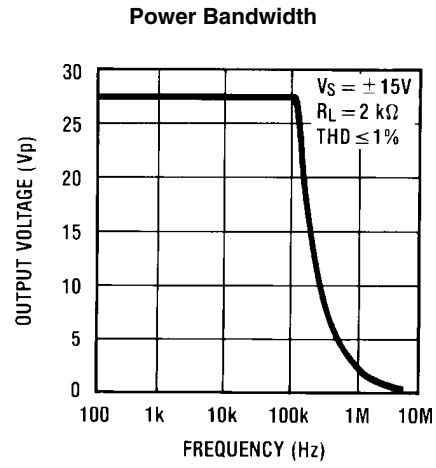
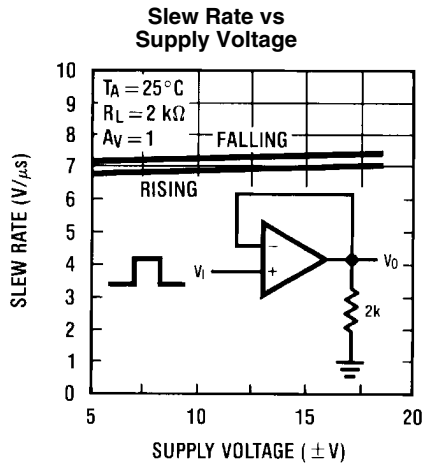


521812

**Slew Rate vs Ambient Temperature**

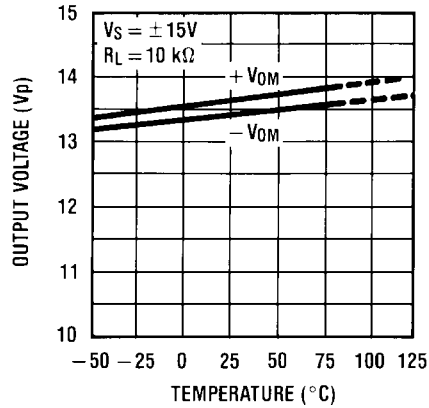


521813



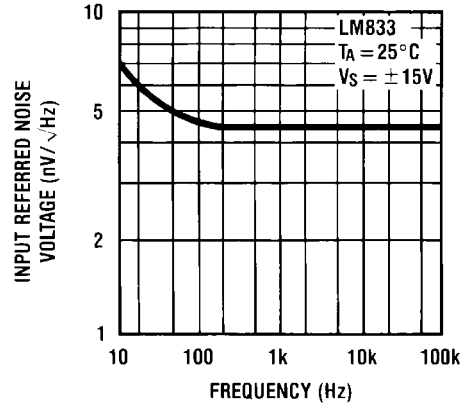


**Maximum Output Voltage vs Ambient Temperature**



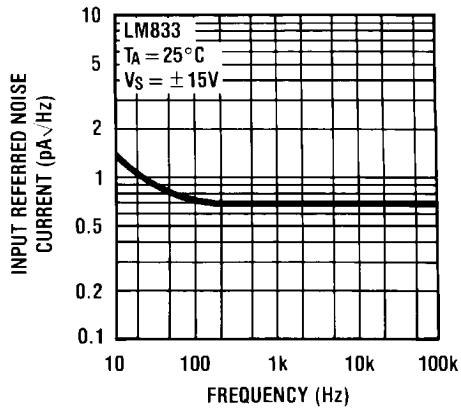
521817

**Spot Noise Voltage vs Frequency**



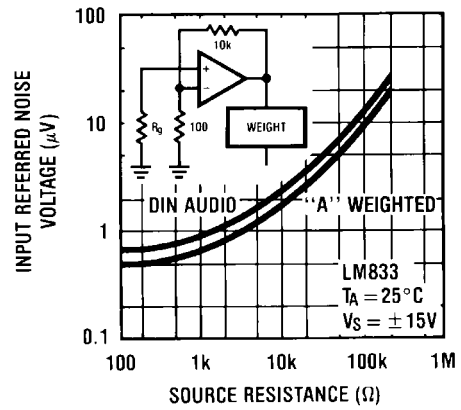
521821

**Spot Noise Current vs Frequency**



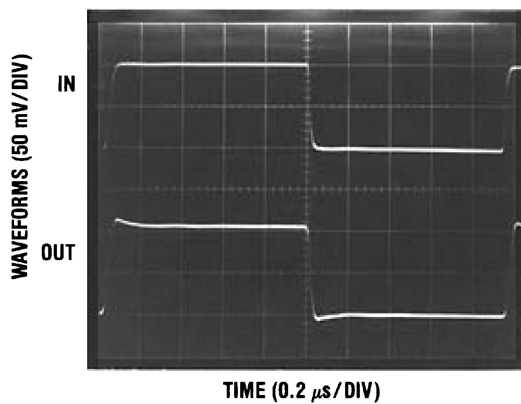
521822

**Input Referred Noise Voltage vs Source Resistance**



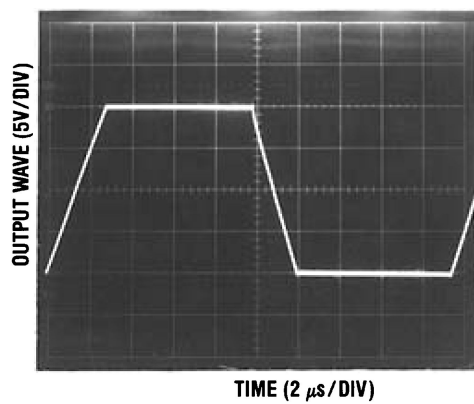
521823

**Noninverting Amp**



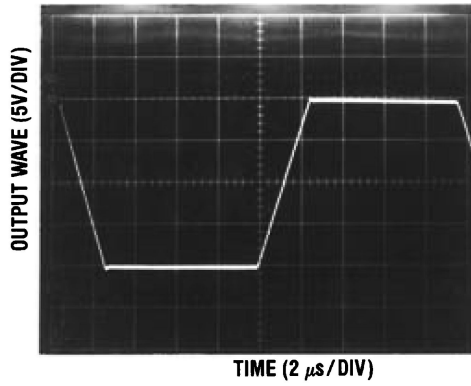
521824

**Noninverting Amp**



521825

Inverting Amp



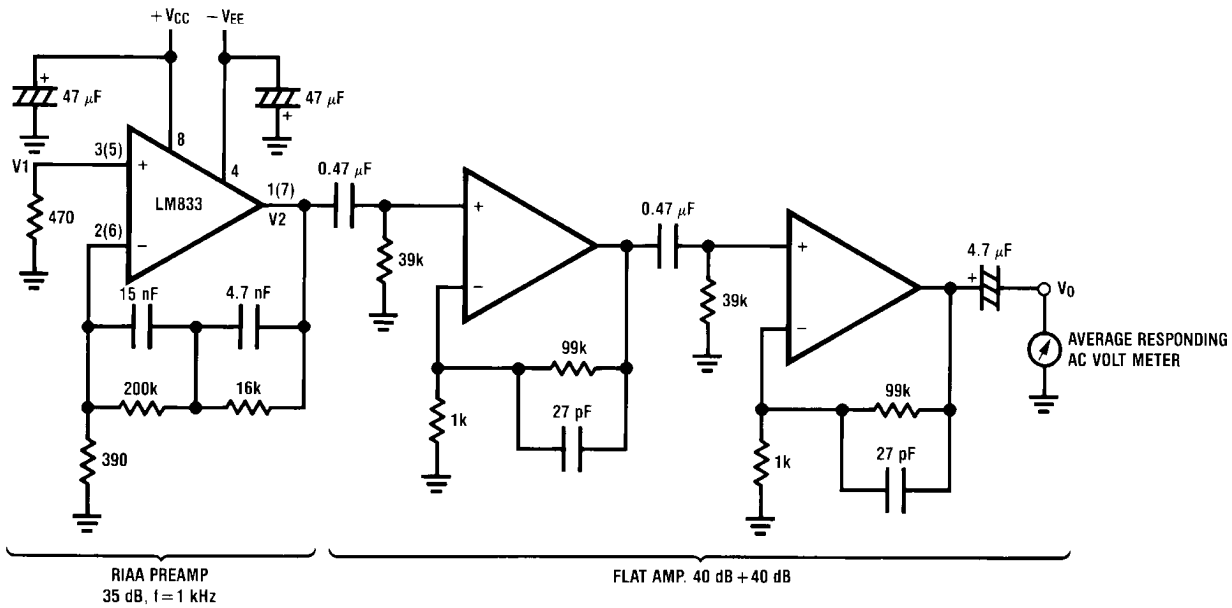
521826

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

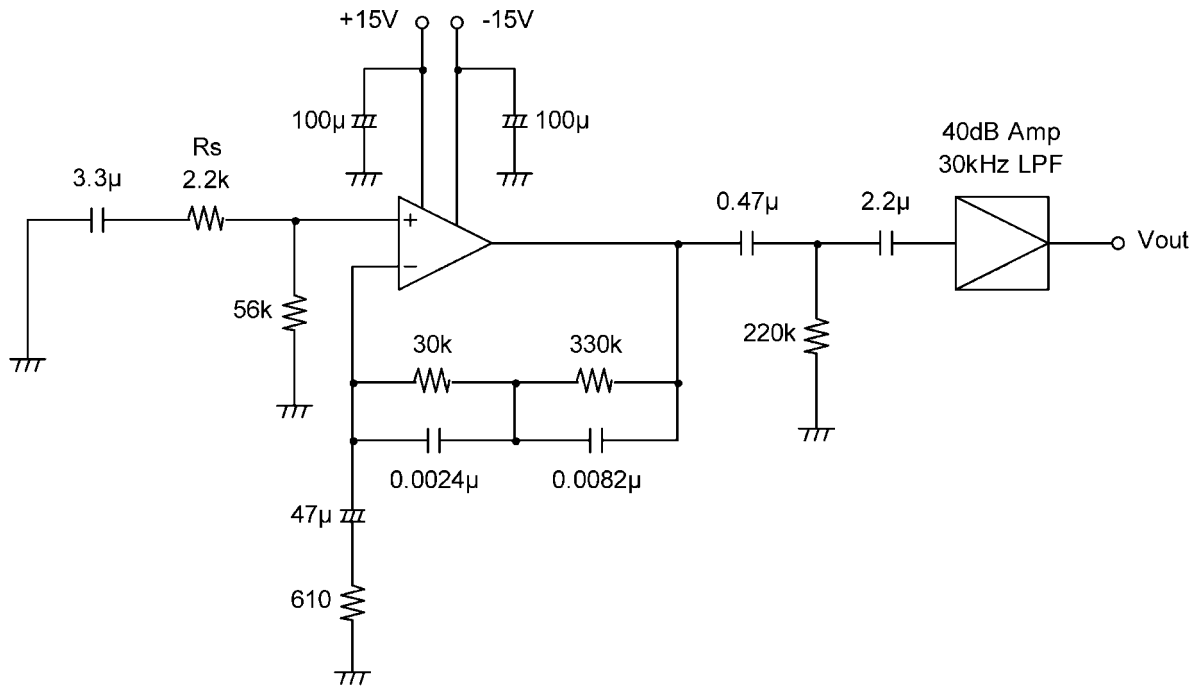


Complete shielding is required to prevent induced pick up from external sources. Always check with oscilloscope for power line noise.

521827

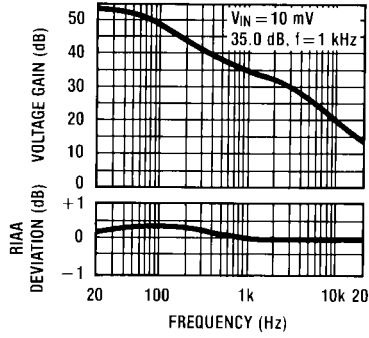
**Total Gain: 115 dB @ f = 1 kHz**  
**Input Referred Noise Voltage:  $e_n = V_0/560,000$  (V)**

### RIAA Noise Voltage Measurement Circuit



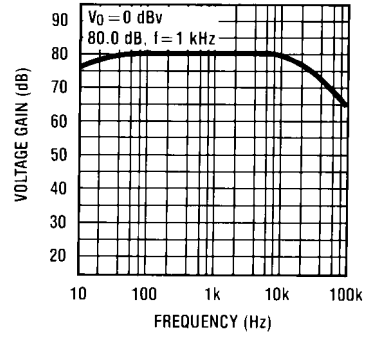
521855

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



521828

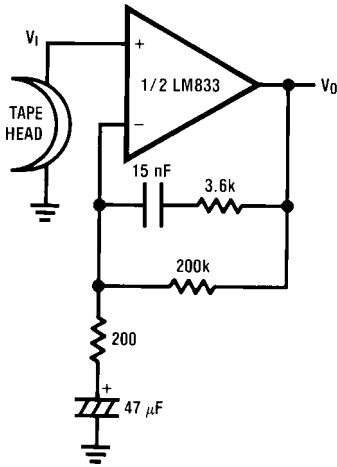
**Flat Amp Voltage Gain vs Frequency**



521829

**Typical Applications**

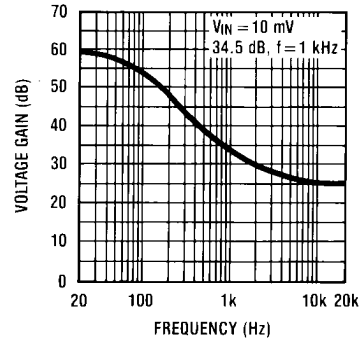
**NAB Preamp**



521830

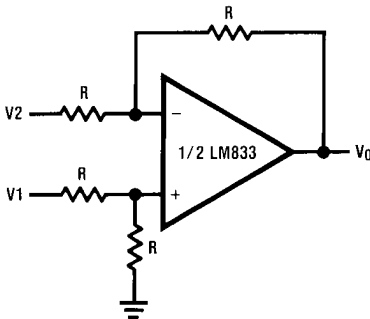
$A_v = 34.5$   
 $F = 1 \text{ kHz}$   
 $E_n = 0.38 \mu\text{V}$   
 A Weighted

**NAB Preamp Voltage Gain vs Frequency**



521831

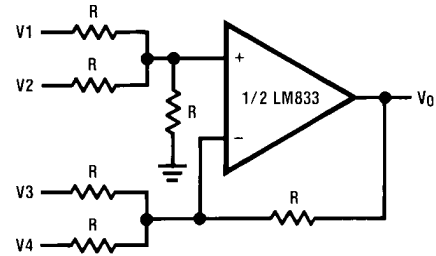
**Balanced to Single Ended Converter**



521832

$V_o = V1 - V2$

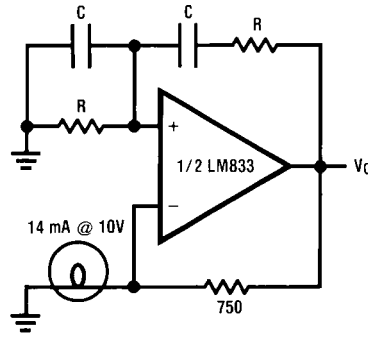
**Adder/Subtractor**



521833

$V_o = V1 + V2 - V3 - V4$

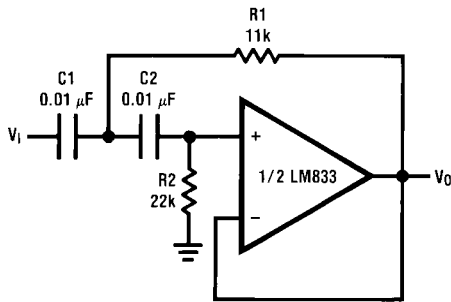
Sine Wave Oscillator



521834

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

Second Order High Pass Filter (Butterworth)



521835

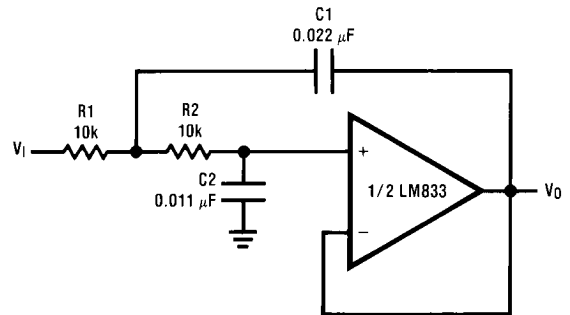
if  $C1 = C2 = C$

$$R1 = \frac{\sqrt{2}}{2\omega_o C}$$

$$R2 = 2 \cdot R1$$

Illustration is  $f_o = 1$  kHz

Second Order Low Pass Filter (Butterworth)



521836

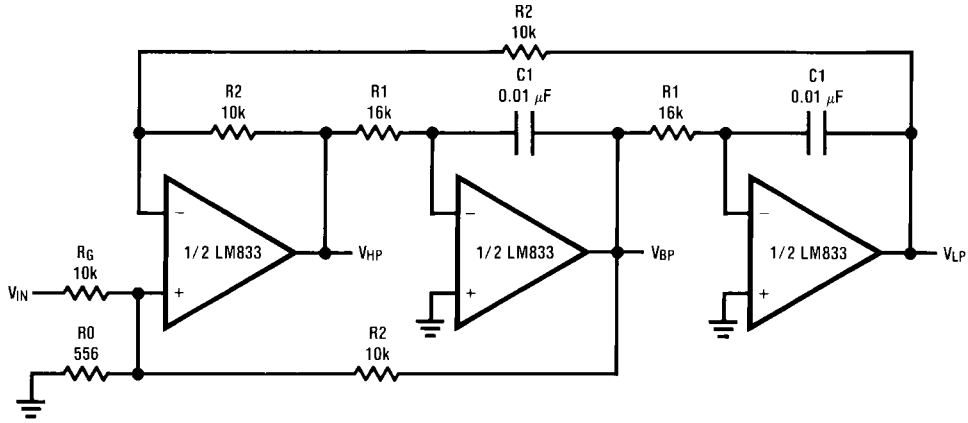
if  $R1 = R2 = R$

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

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

Illustration is  $f_o = 1$  kHz

State Variable Filter

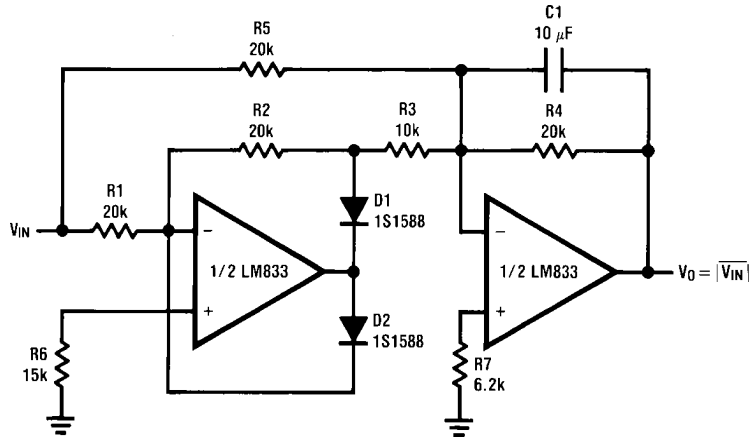


521837

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

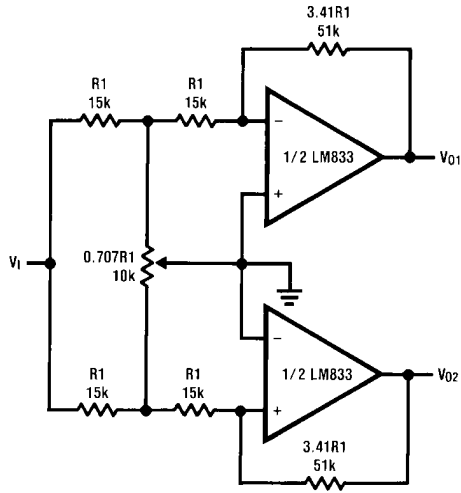
Illustration is  $f_0 = 1 \text{ kHz}$ ,  $Q = 10$ ,  $A_{BP} = 1$

AC/DC Converter



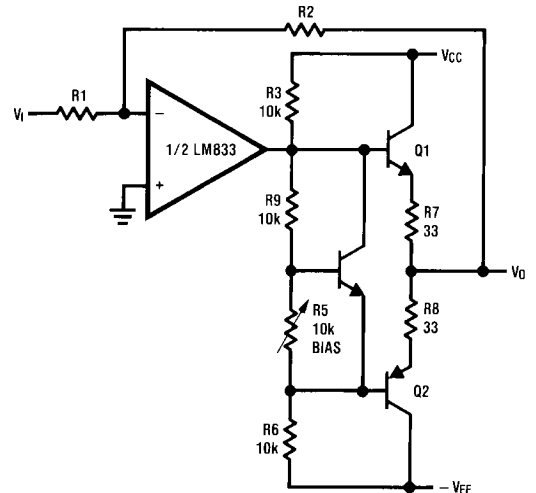
521838

**2 Channel Panning Circuit (Pan Pot)**



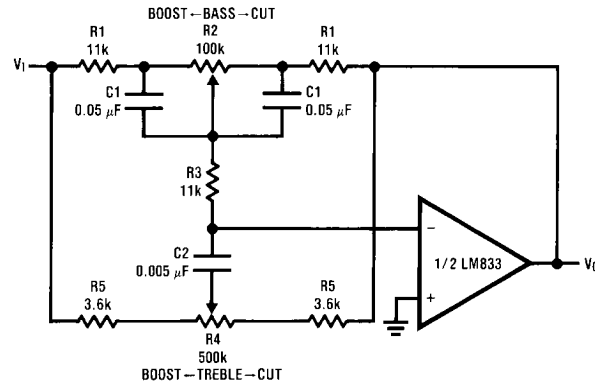
521839

**Line Driver**



521840

**Tone Control**



521841

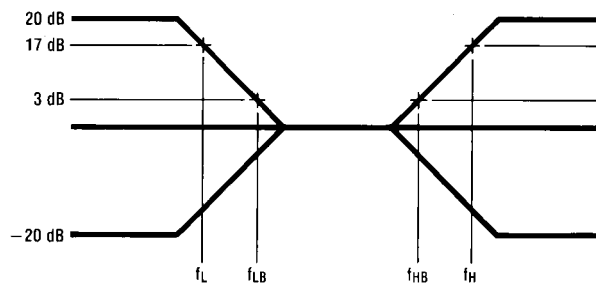
$$f_L = \frac{1}{2\pi R_2 C_1}, f_{LB} = \frac{1}{2\pi R_1 C_1}$$

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

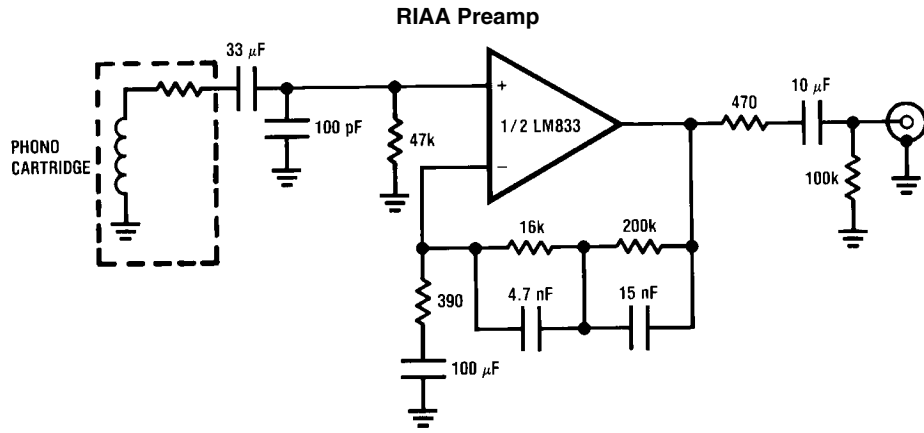
Illustration is:

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

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

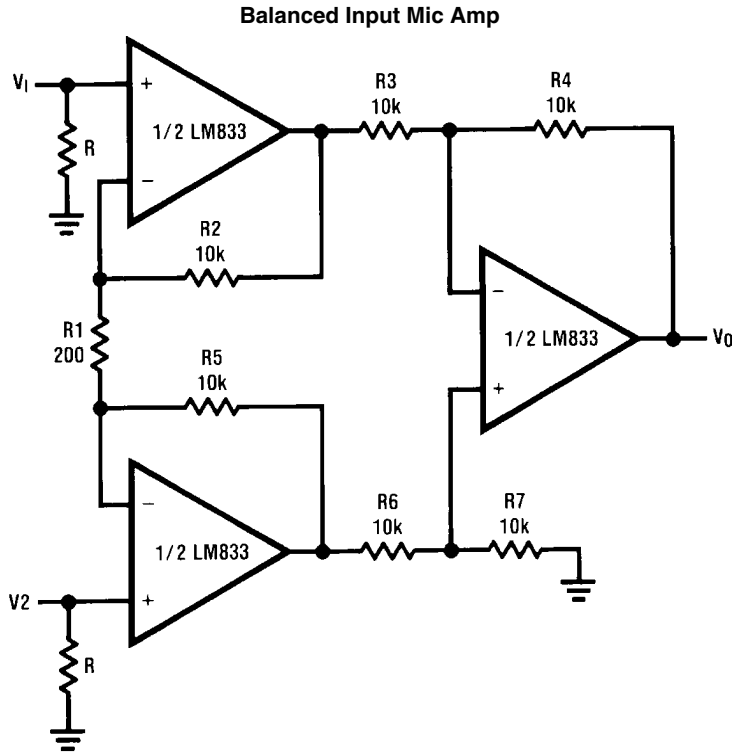


521842



521803

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



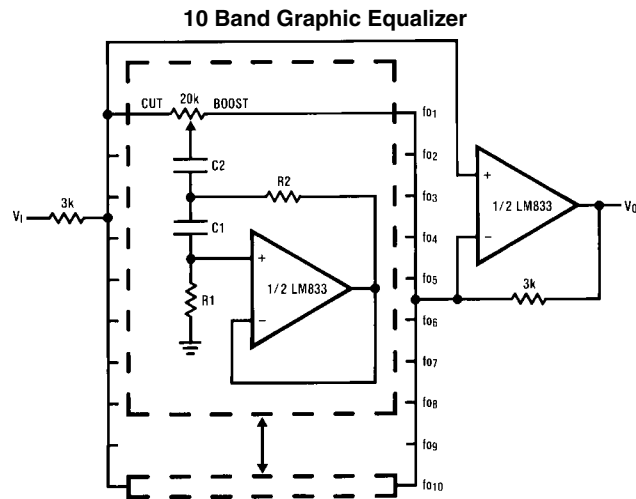
521843

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:  
 $V_0 = 101(V_2 - V_1)$





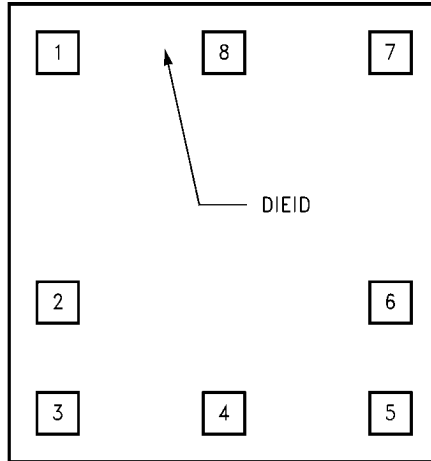
521844

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

**Note 7:** At volume of change =  $\pm 12$  dB

Q = 1.7

Reference: "AUDIO/RADIO HANDBOOK", National Semiconductor, 1980, Page 2-61

**LM833 MDC MWC  
DUAL AUDIO OPERATIONAL AMPLIFIER**

**Die Layout (A - Step)**

521854

**Die/Wafer Characteristics**

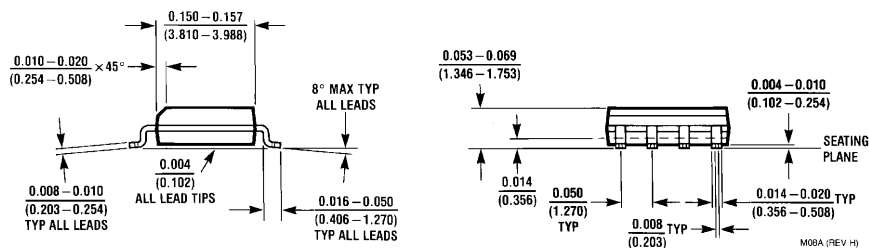
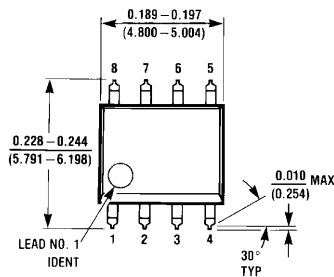
Fabrication Attributes		General Die Information	
Physical Die Identification	LM833A	Bond Pad Opening Size (min)	110 $\mu$ m x 110 $\mu$ m
Die Step	A	Bond Pad Metalization	ALUMINUM
<b>Physical Attributes</b>		Passivation	VOM NITRIDE
Wafer Diameter	150mm	Back Side Metal	BARE BACK
Die Size (Drawn)	1219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

**Special Assembly Requirements:**
**Note: Actual die size is rounded to the nearest micron.**

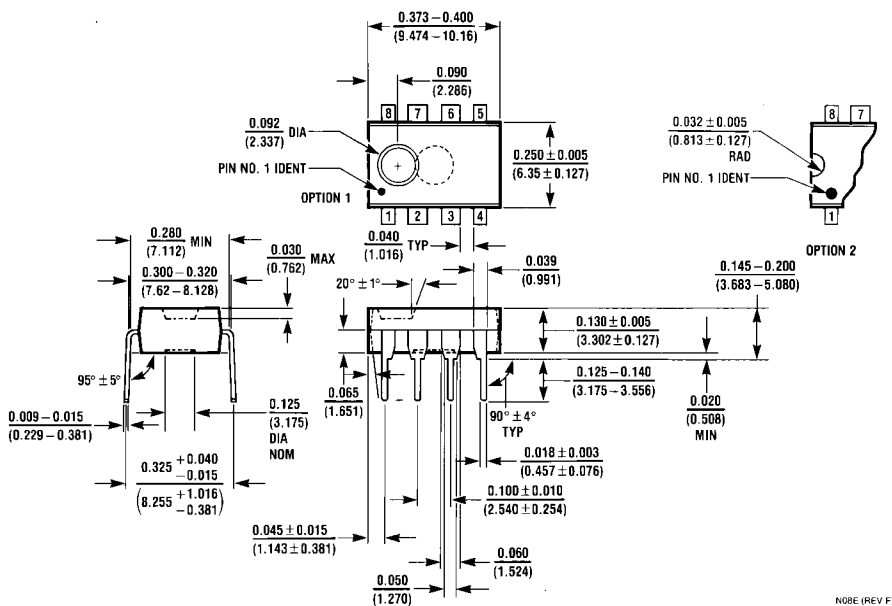
Die Bond Pad Coordinate Locations (A - Step)						
(Referenced to die center, coordinates in $\mu$ m) NC = No Connection						
SIGNAL NAME	PAD NUMBER	X/Y COORDINATES		PAD SIZE		
		X	Y	X		Y
OUTPUT A	1	-476	500	110	x	110
INPUT A-	2	-476	-212	110	x	110
INPUT A+	3	-476	-500	110	x	110
VEE-	4	-0	-500	110	x	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

<b>IN U.S.A</b>	
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Fax:	49 (0) 8141 351470
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Tel:	(852) 27371701
<b>IN JAPAN</b>	
Tel:	81 043 299 2308

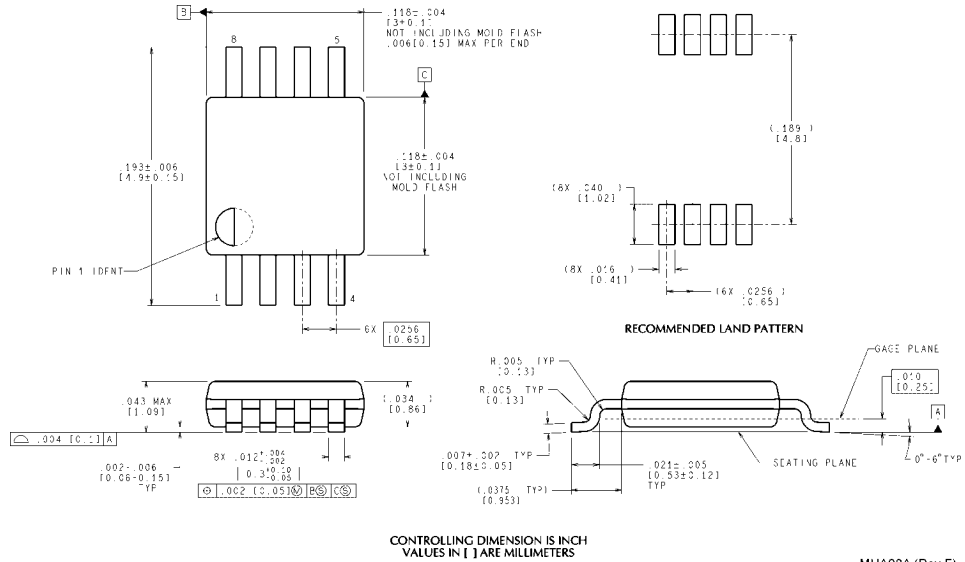
**Physical Dimensions** inches (millimeters) unless otherwise noted



**Molded Small Outline Package (M)**  
**Order Number LM833M or LM833MX**  
**LM833AM, LM833AMX**  
**NS Package Number M08A**



**Molded Dual-In-Line Package (N)**  
**Order Number LM833N**  
**NS Package Number N08E**



**8-Lead (0.118" Wide) Molded Mini Small Outline Package**  
**Order Number LM833MM or LM833MMX**  
**NS Package Number MUA08A**

MUA08A (Rev F)



# Notes

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