

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.

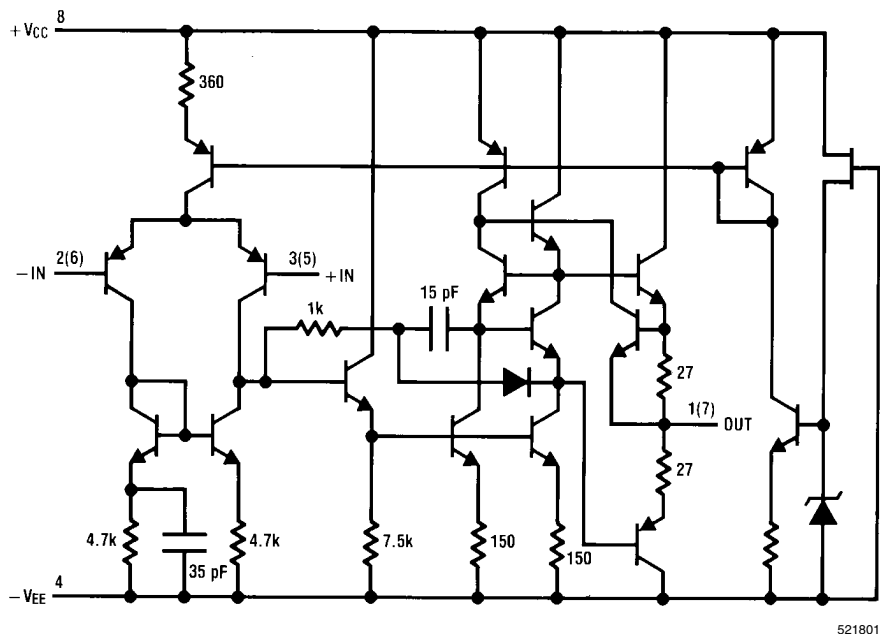
The LM833 is pin-for-pin compatible with industry standard dual operational amplifiers.

Features

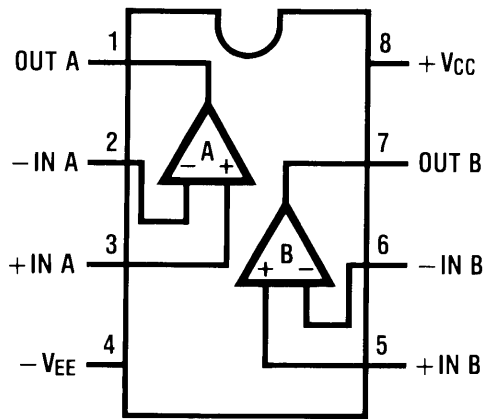
- Wide dynamic range: >140dB
- Low input noise voltage: $4.5\text{nV}/\sqrt{\text{Hz}}$
- High slew rate: $7\text{ V}/\mu\text{s}$ (typ); $5\text{ V}/\mu\text{s}$ (min)
- High gain bandwidth: 15MHz (typ); 10MHz (min)
- Wide power bandwidth: 120KHz
- Low distortion: 0.002%
- Low offset voltage: 0.3mV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

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	$R_L = 10\text{ k}\Omega$	± 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	$V_{IN} = \pm 12V$	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/ μs
GBW	Gain Bandwidth Product	$f = 100\text{ kHz}$	10	15		MHz
V_{NI}	Equivalent Input Noise Voltage (LM833AM, LM833AMX)	RIAA, $R_S = 2.2\text{ k}\Omega$ <i>(Note 6)</i>			1.4	μV

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
ϕ_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.

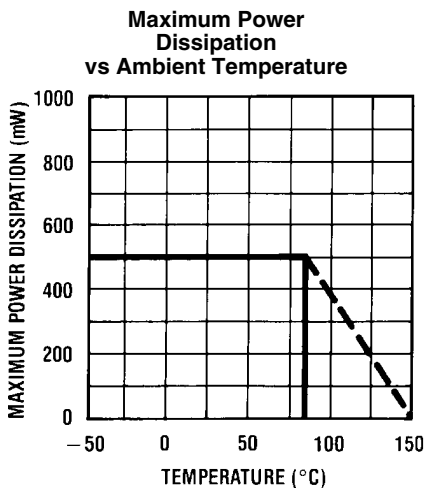
Note 3: If supply voltage is less than $\pm 15V$, it is equal to supply voltage.

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

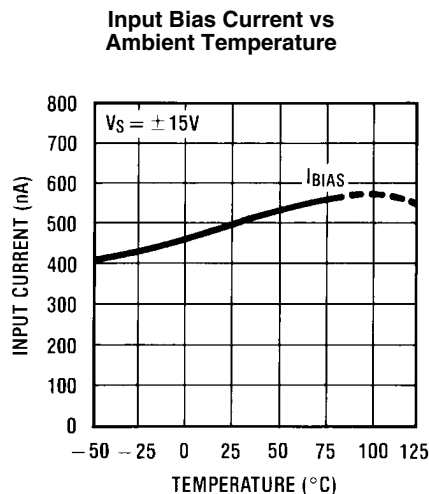
Note 5: Human body model, 1.5 k Ω in series with 100 pF.

Note 6: RIAA Noise Voltage Measurement Circuit

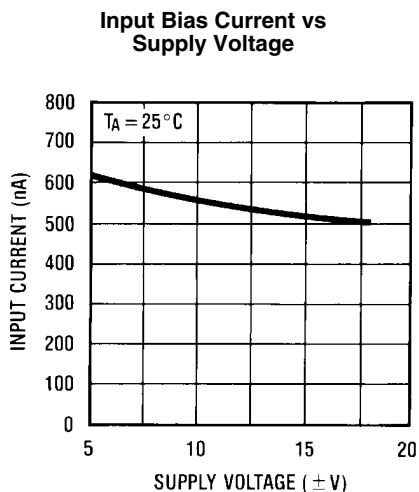
Typical Performance Characteristics



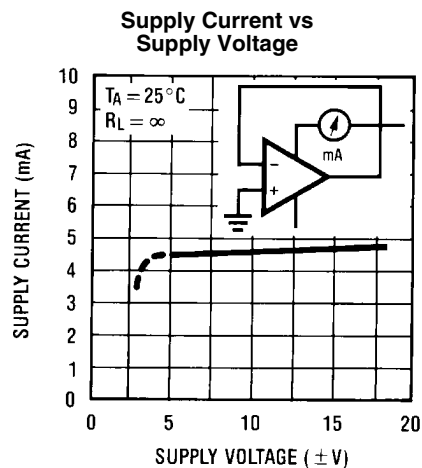
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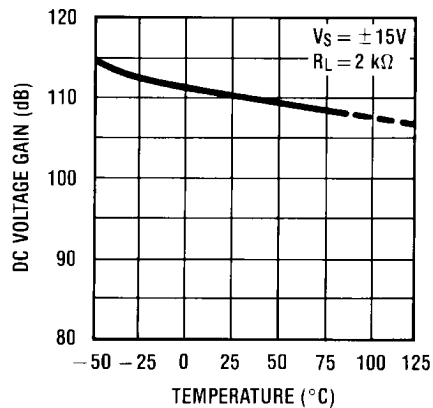


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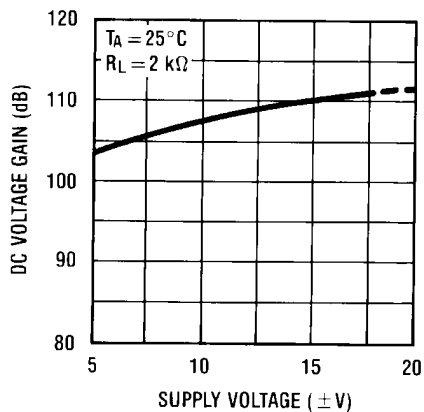
521807

DC Voltage Gain vs Ambient Temperature



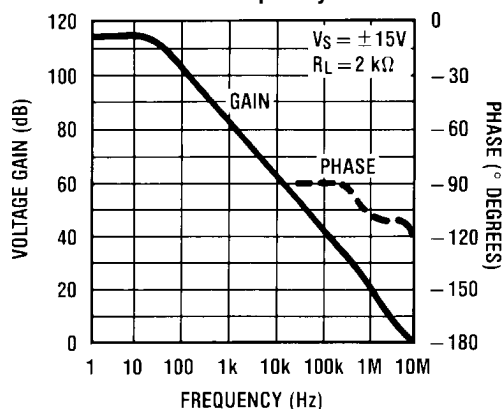
521808

DC Voltage Gain vs Supply Voltage



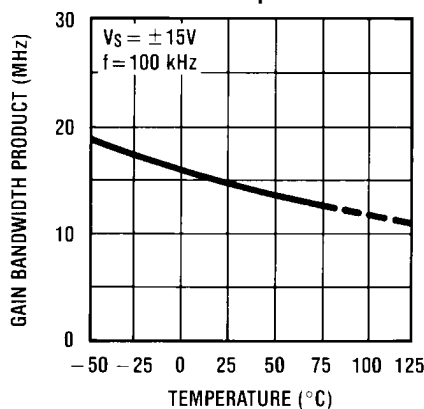
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Voltage Gain & Phase vs Frequency



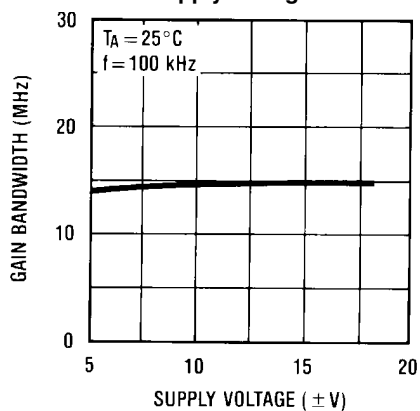
521810

Gain Bandwidth Product vs Ambient Temperature



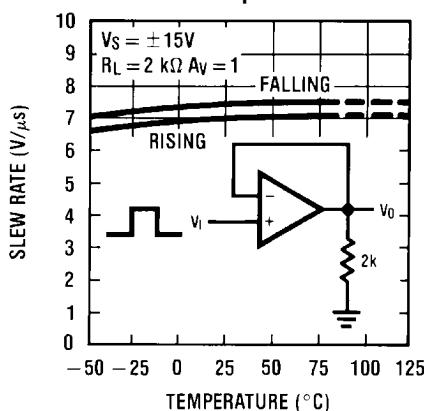
521811

Gain Bandwidth vs Supply Voltage

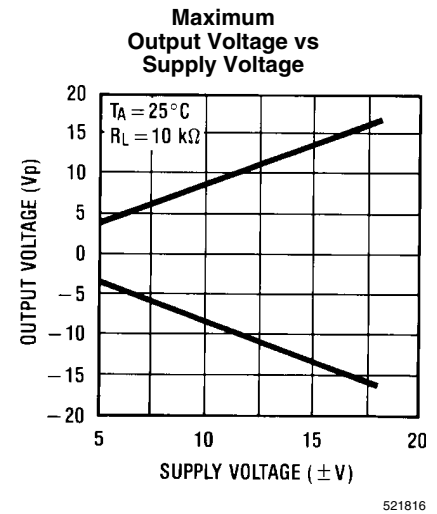
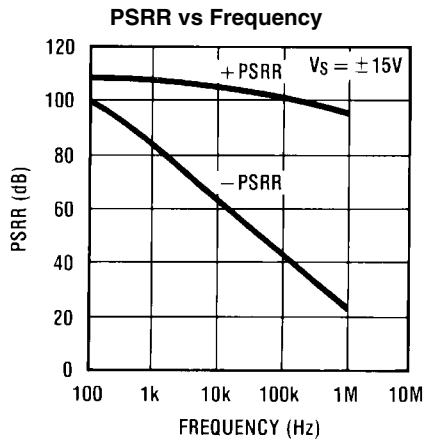
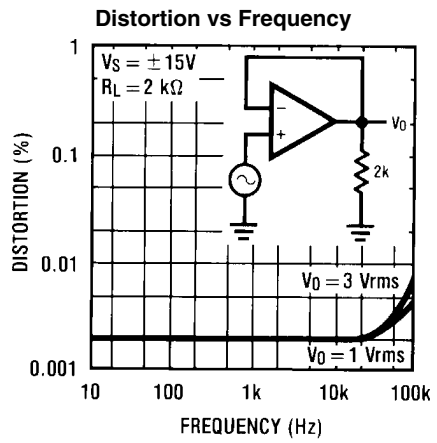
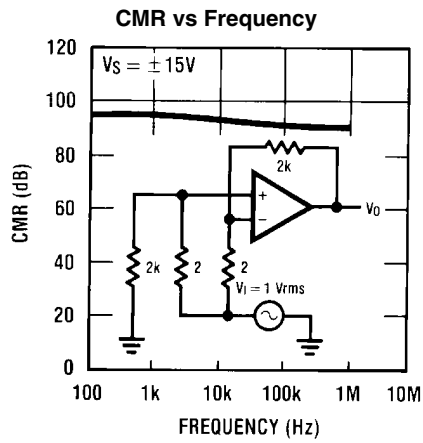
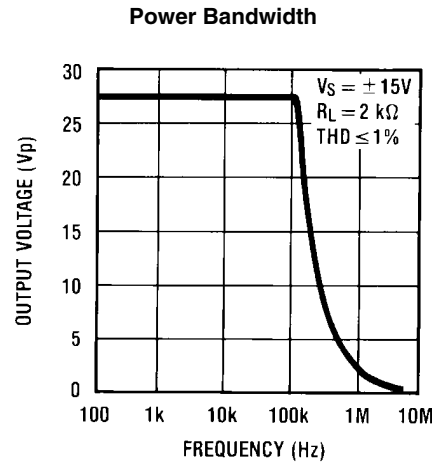
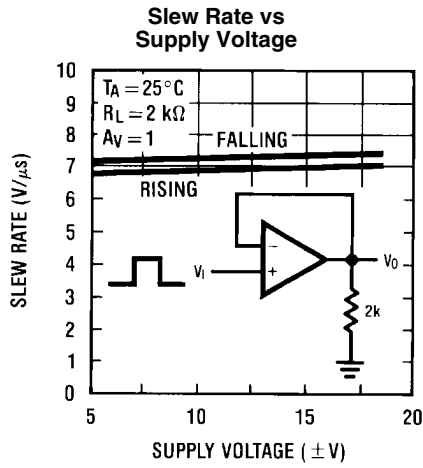


521812

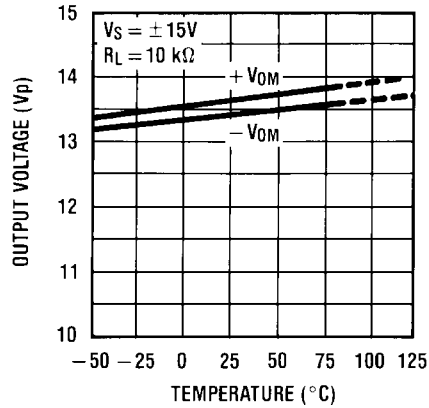
Slew Rate vs Ambient Temperature



521813

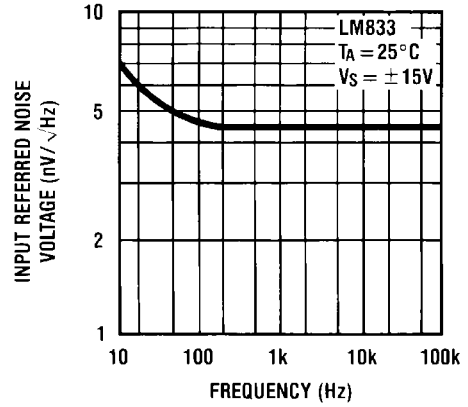


Maximum Output Voltage vs Ambient Temperature



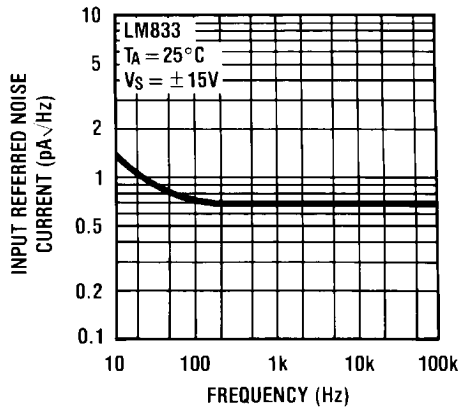
521817

Spot Noise Voltage vs Frequency



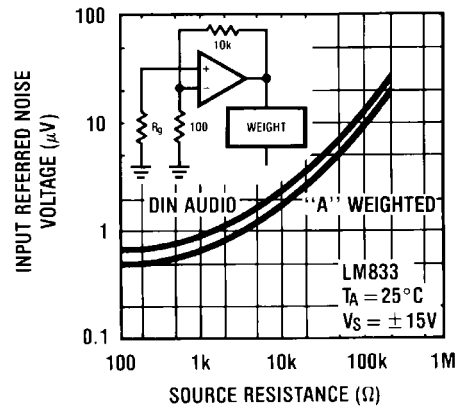
521821

Spot Noise Current vs Frequency



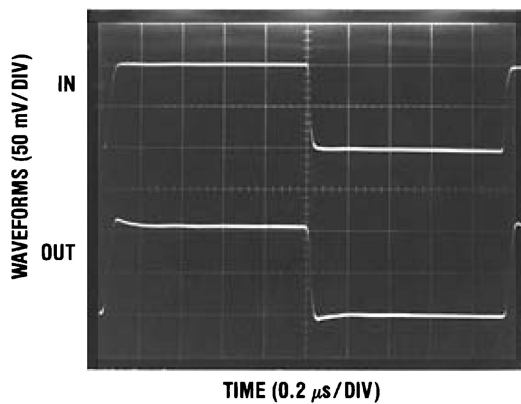
521822

Input Referred Noise Voltage vs Source Resistance



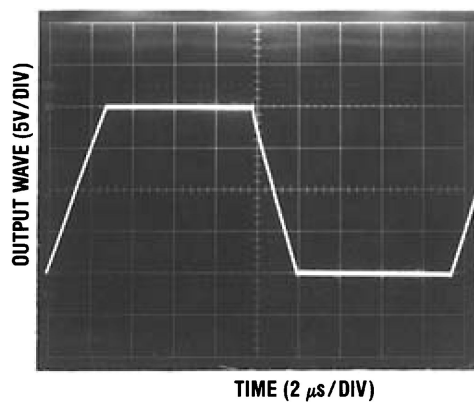
521823

Noninverting Amp



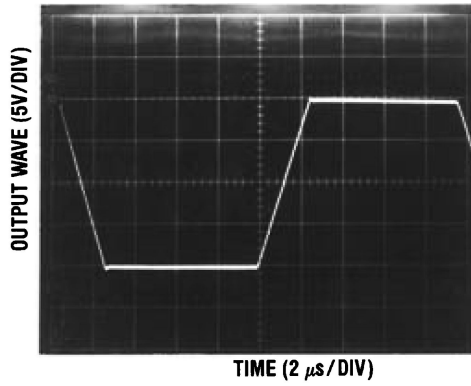
521824

Noninverting Amp



521825

Inverting Amp



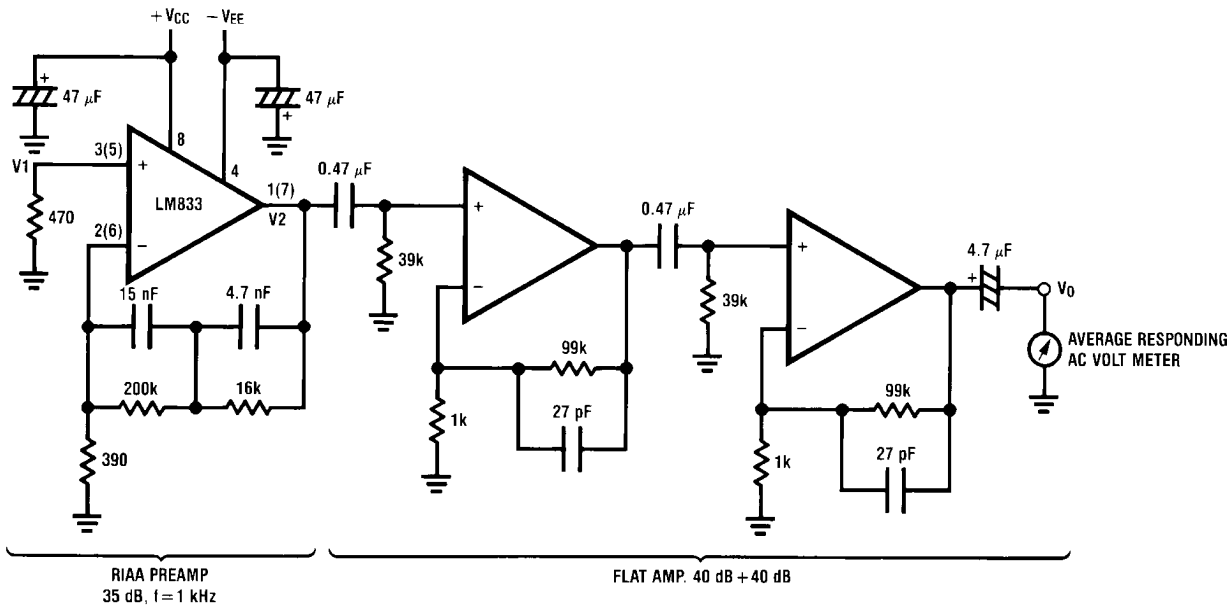
521826

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

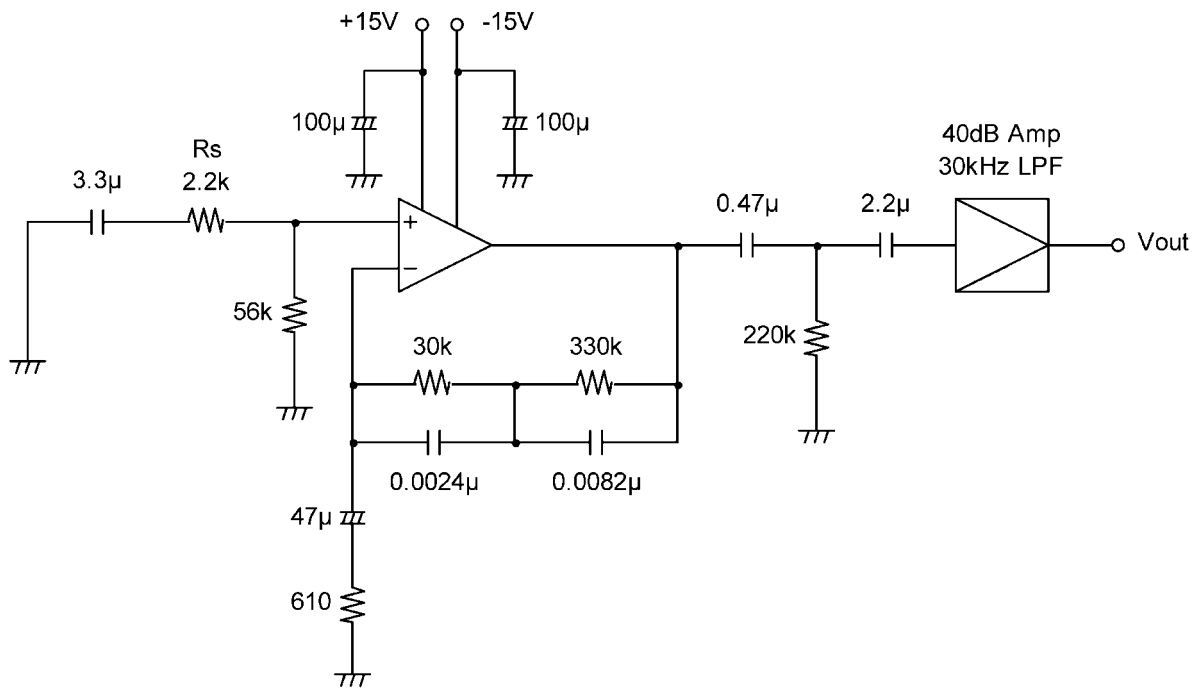


Complete shielding is required to prevent induced pick up from external sources. Always check with oscilloscope for power line noise.

521827

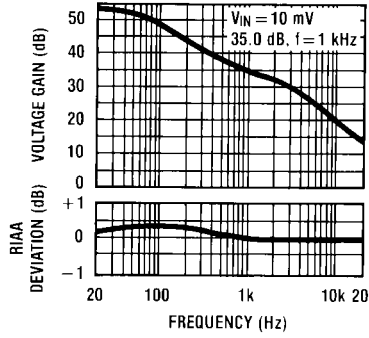
Total Gain: 115 dB @ f = 1 kHz
Input Referred Noise Voltage: $e_n = V_0/560,000$ (V)

RIAA Noise Voltage Measurement Circuit



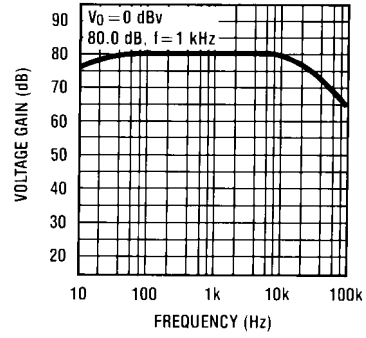
521855

RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency



521828

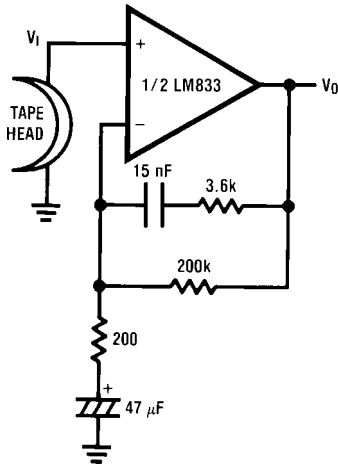
Flat Amp Voltage Gain vs Frequency



521829

Typical Applications

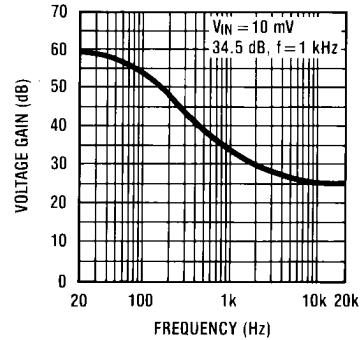
NAB Preamp



521830

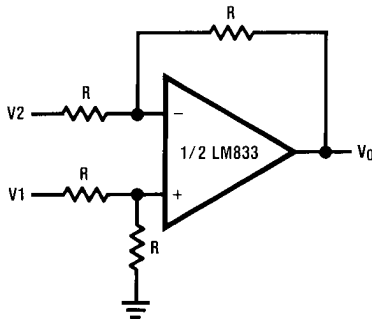
$A_v = 34.5$
 $F = 1 \text{ kHz}$
 $E_n = 0.38 \mu\text{V}$
 A Weighted

NAB Preamp Voltage Gain vs Frequency



521831

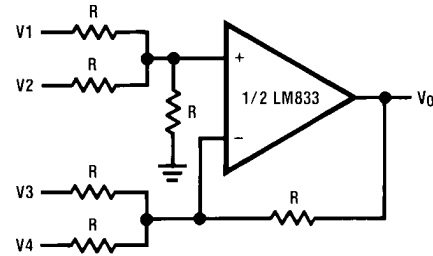
Balanced to Single Ended Converter



521832

$V_O = V1 - V2$

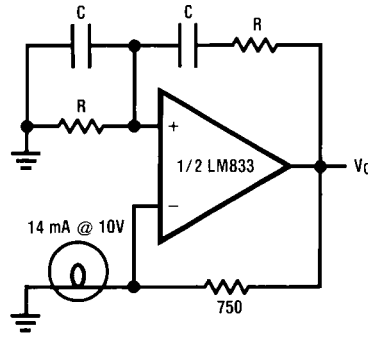
Adder/Subtracter



521833

$V_O = V1 + V2 - V3 - V4$

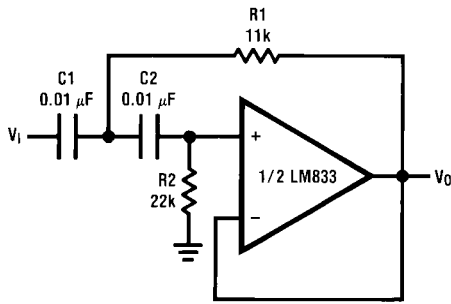
Sine Wave Oscillator



521834

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

Second Order High Pass Filter (Butterworth)



521835

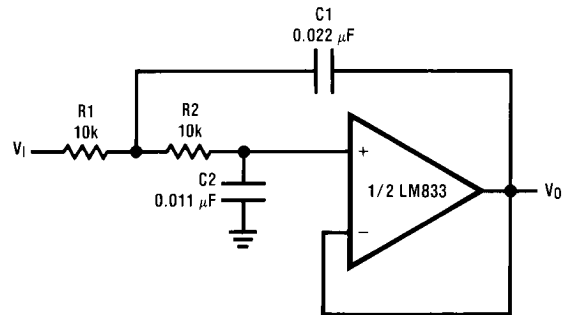
if $C1 = C2 = C$

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

$$R2 = 2 \cdot R1$$

Illustration is $f_o = 1$ kHz

Second Order Low Pass Filter (Butterworth)



521836

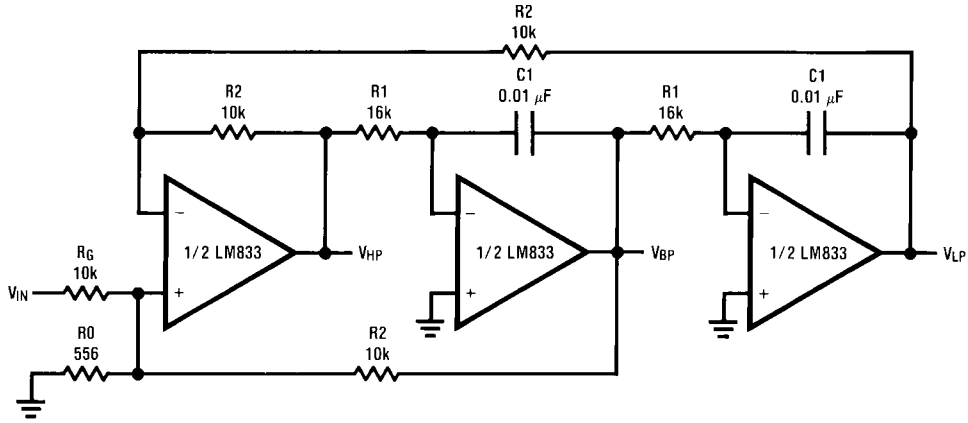
if $R1 = R2 = R$

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

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

Illustration is $f_o = 1$ kHz

State Variable Filter

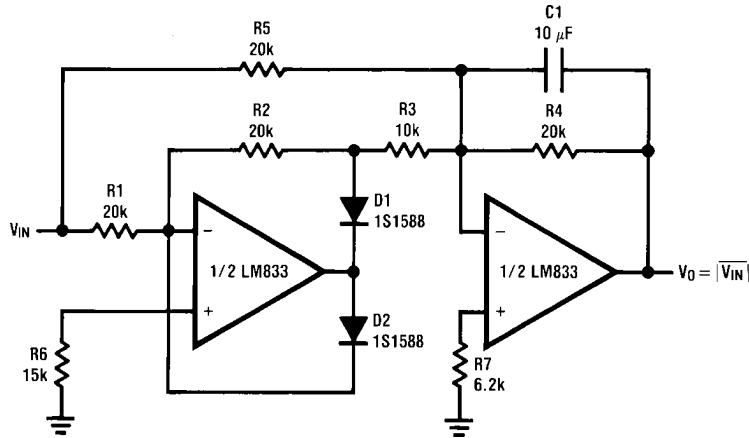


521837

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

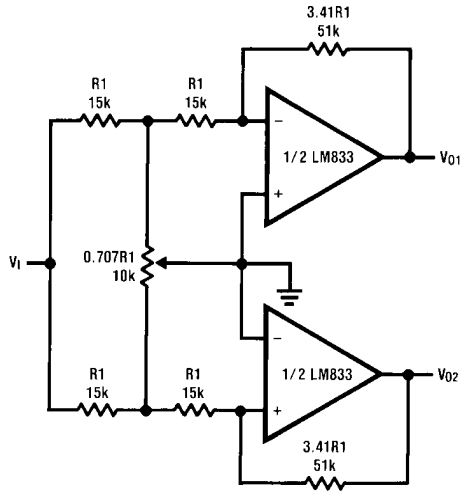
Illustration is $f_0 = 1 \text{ kHz}$, $Q = 10$, $A_{BP} = 1$

AC/DC Converter



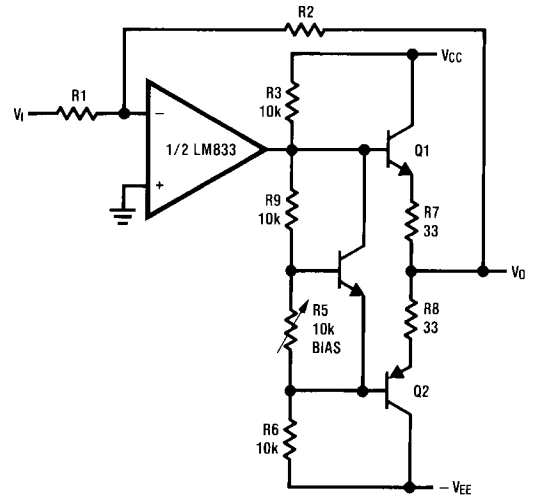
521838

2 Channel Panning Circuit (Pan Pot)



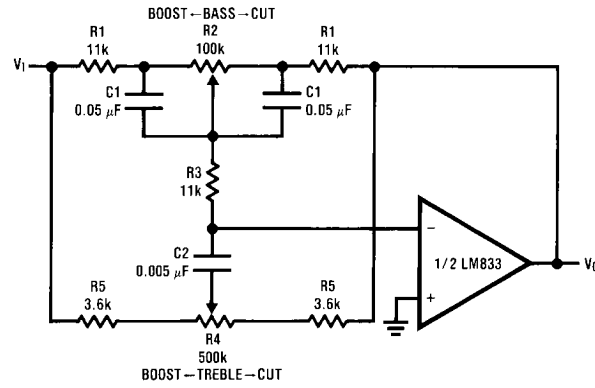
521839

Line Driver



521840

Tone Control



521841

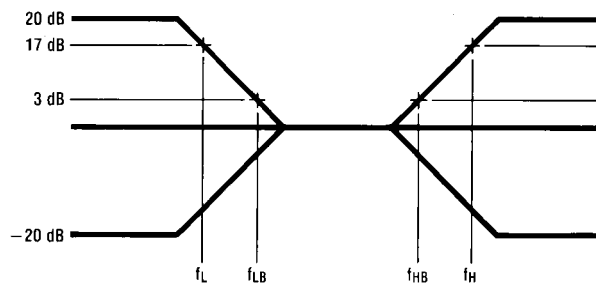
$$f_L = \frac{1}{2\pi R_2 C_1}, f_{LB} = \frac{1}{2\pi R_1 C_1}$$

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

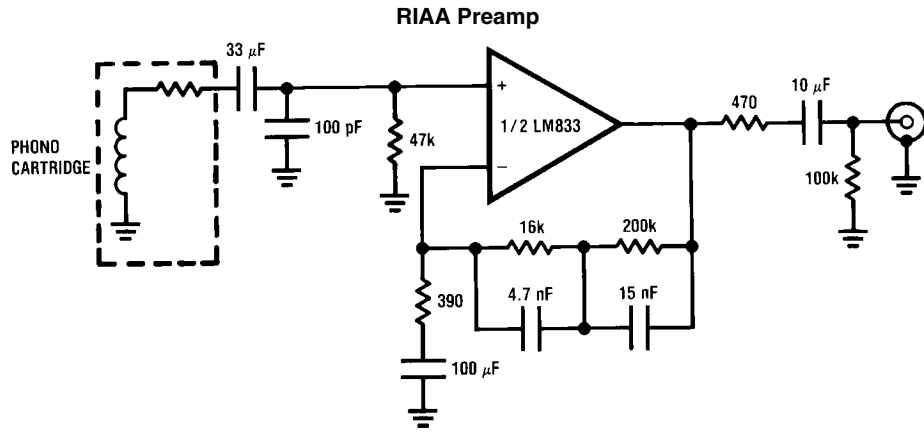
Illustration is:

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

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

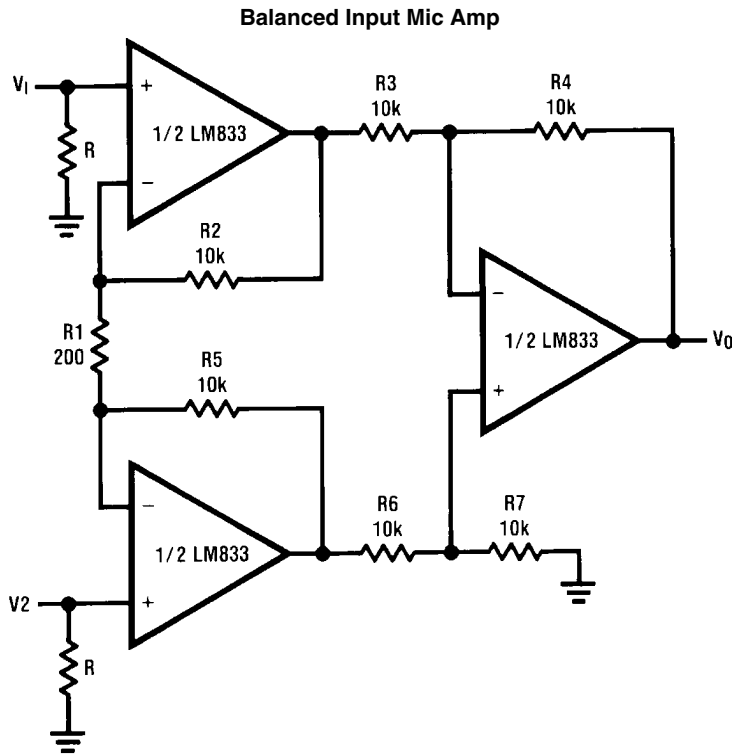


521842



521803

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

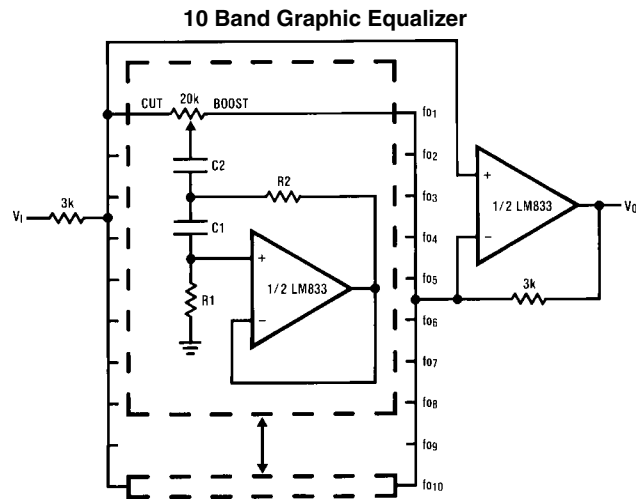


521843

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:
 $V_0 = 101(V_2 - V_1)$



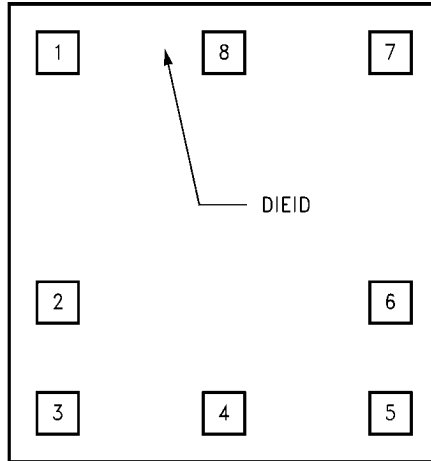
521844

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

Note 7: At volume of change = ± 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

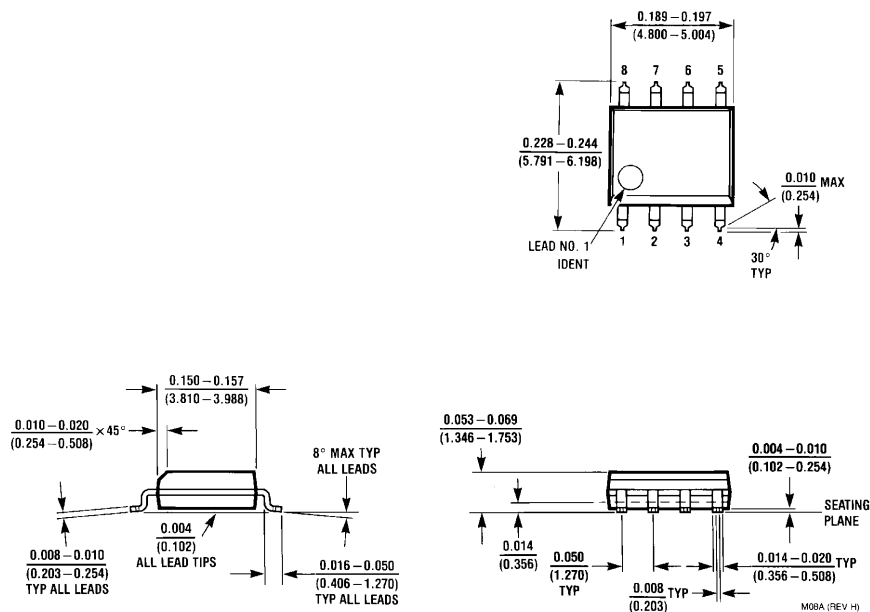
Fabrication Attributes		General Die Information	
Physical Die Identification	LM833A	Bond Pad Opening Size (min)	110 μ m x 110 μ m
Die Step	A	Bond Pad Metalization	ALUMINUM
Physical Attributes		Passivation	VOM NITRIDE
Wafer Diameter	150mm	Back Side Metal	BARE BACK
Die Size (Drawn)	1219 μ m x 1270 μ m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

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

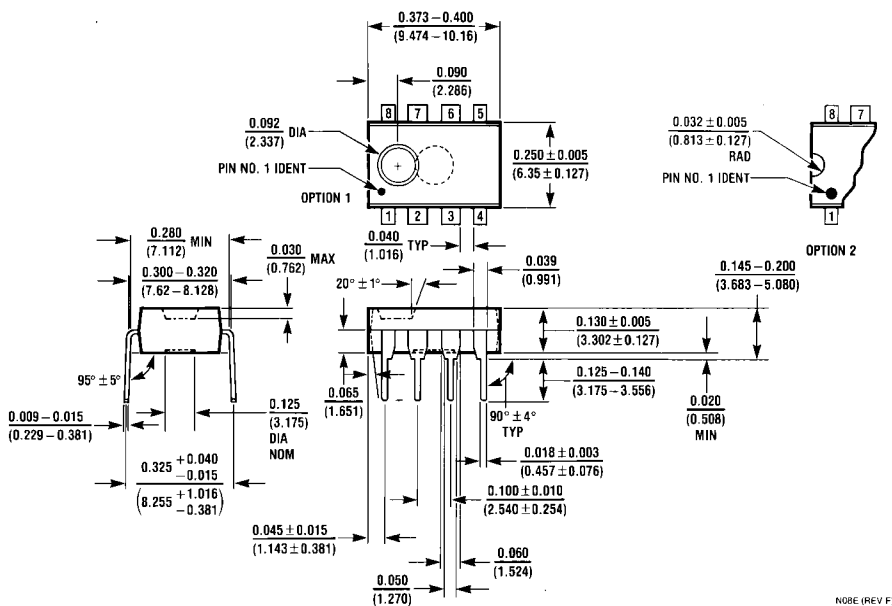
Die Bond Pad Coordinate Locations (A - Step)						
(Referenced to die center, coordinates in μ m) NC = No Connection						
SIGNAL NAME	PAD NUMBER	X/Y COORDINATES		PAD SIZE		
		X	Y	X		Y
OUTPUT A	1	-476	500	110	x	110
INPUT A-	2	-476	-212	110	x	110
INPUT A+	3	-476	-500	110	x	110
VEE-	4	-0	-500	110	x	110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

IN U.S.A	
Tel #:	1 877 Dial Die 1 877 342 5343
Fax:	1 207 541 6140
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

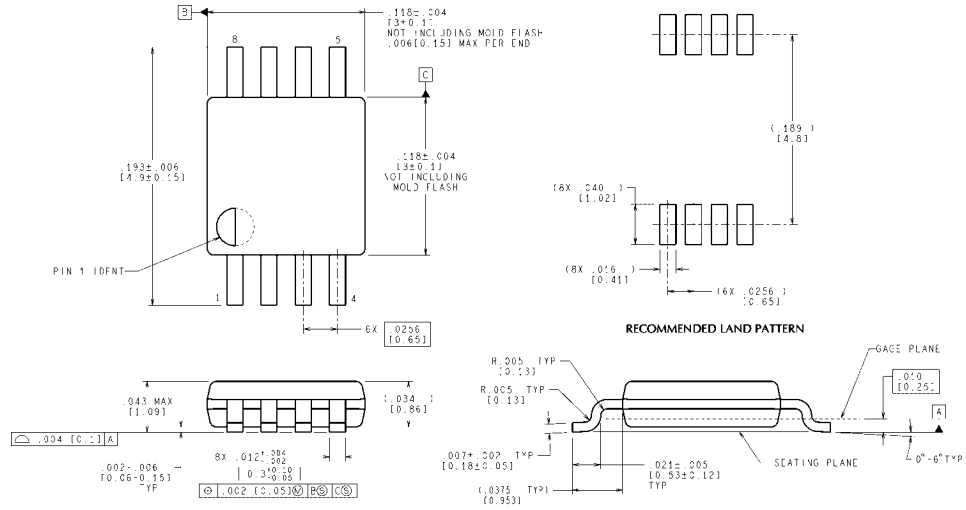
Physical Dimensions inches (millimeters) unless otherwise noted



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

IMPORTANT NOTICE

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