National Semiconductor

August 2000

LM833
Dual Audio Operational Amplifier

General Description

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

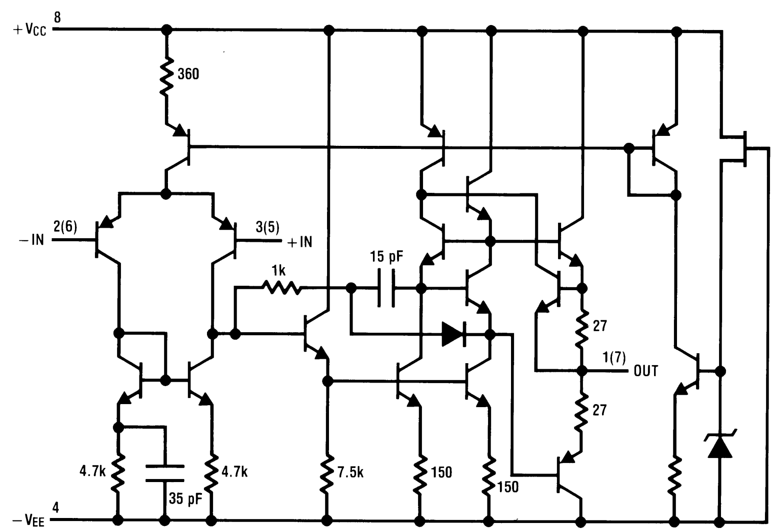
This dual amplifier IC utilizes new circuit and processing techniques to deliver low noise, high speed and wide bandwidth without increasing external components or decreasing stability. The LM833 is internally compensated for all closed loop gains and is therefore optimized for all preamp and high level 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: 4.5nV/√Hz
- High slew rate: 7 V/µs (typ); 5V/µs (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)



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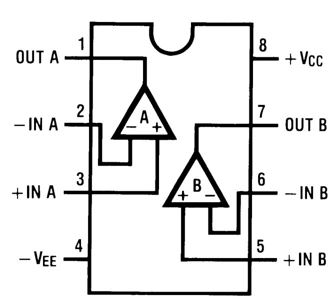
Connection Diagram



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

 DS005218

Absolute Maximum Ratings (Note 1)

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

Supply Voltage V_{CC}–V_{EE}	36V
Differential Input Voltage (Note 3) V_I	±30V
Input Voltage Range (Note 3) V_{IC}	±15V
Power Dissipation (Note 4) P_D	500 mW
Operating Temperature Range T_{OPR}	−40 ~ 85˚C
Storage Temperature Range T_{STG}	−60 ~ 150˚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

See AN-450 “Surface Mounting Methods and Their Effect on Product Reliability” for other methods of soldering surface mount devices.

ESD tolerance (Note 5) 1600V

DC Electrical Characteristics (Notes 1, 2)

(T_A = 25˚C, V_S = ±15V)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{OS}	Input Offset Voltage	R_S = 10Ω		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 kΩ, V_O = ±10V	90	110		dB
V_{OM}	Output Voltage Swing	R_L = 10 kΩ	±12	±13.5		V
		R_L = 2 kΩ	±10	±13.4		V
V_{CM}	Input Common-Mode Range		±12	±14.0		V
CMRR	Common-Mode Rejection Ratio	V_{IN} = ±12V	80	100		dB
PSRR	Power Supply Rejection Ratio	V_S = 15~5V, −15~−5V	80	100		dB
I_Q	Supply Current	V_O = 0V, Both Amps		5	8	mA

AC Electrical Characteristics

(T_A = 25˚C, V_S = ±15V, R_L = 2 kΩ)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
SR	Slew Rate	R_L = 2 kΩ	5	7		V/µs
GBW	Gain Bandwidth Product	f = 100 kHz	10	15		MHz

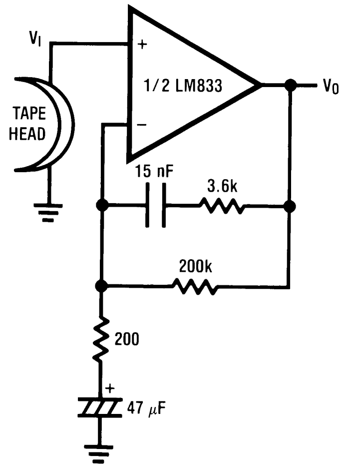
Design Electrical Characteristics

(T_A = 25˚C, V_S = ±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	µV/˚C
THD	Distortion	R_L = 2 kΩ, f = 20~20 kHz, V_{OUT} = 3 Vrms, A_V = 1	0.002	%
e_n	Input Referred Noise Voltage	R_S = 100Ω, f = 1 kHz	4.5	$nV/\sqrt{Hz}$
i_n	Input Referred Noise Current	f = 1 kHz	0.7	$pA/\sqrt{Hz}$
PBW	Power Bandwidth	V_O = 27 V_{pp}, R_L = 2 kΩ, THD ≤ 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 = 20~20 kHz	−120	dB

Typical Applications

NAB Preamp



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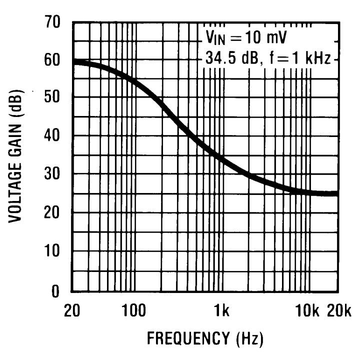
A_V = 34.5
F = 1 kHz
E_n = 0.38 µV
A Weighted

NAB Preamp Voltage Gain vs Frequency



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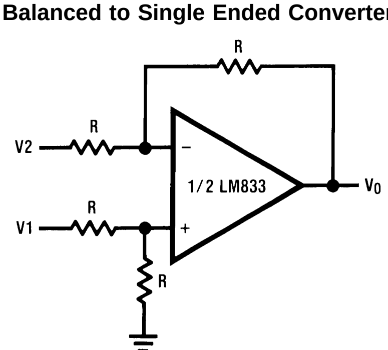
Balanced to Single Ended Converter



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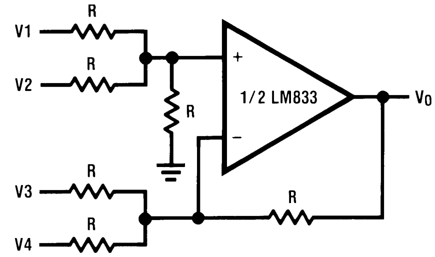
V_O = V1–V2

Adder/Subtracter



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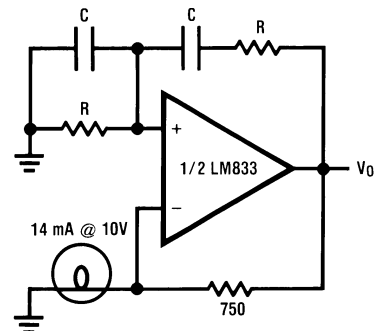
V_O = V1 + V2 − V3 − V4

Sine Wave Oscillator



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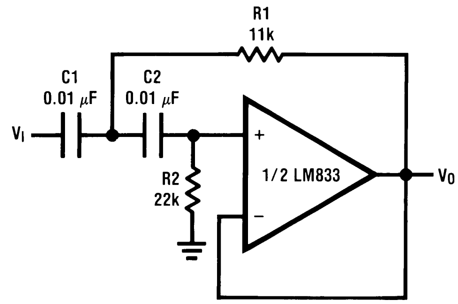
$$f_o = \frac{1}{2\pi RC}$$

Typical Applications (Continued)

Second Order High Pass Filter (Butterworth)



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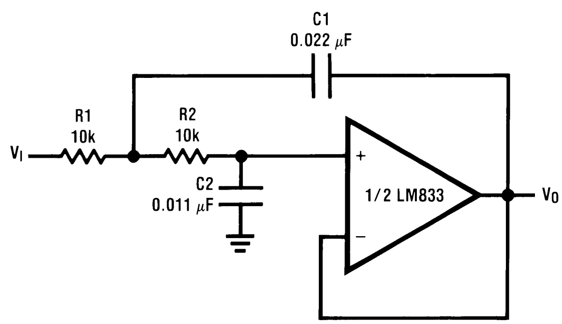
if C1 = C2 = C

$$R1 = \frac{\sqrt{2}}{2\omega_0 C}$$

$$R2 = 2 \bullet R1$$

Illustration is f_0 = 1 kHz

Second Order Low Pass Filter (Butterworth)



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if R1 = R2 = R

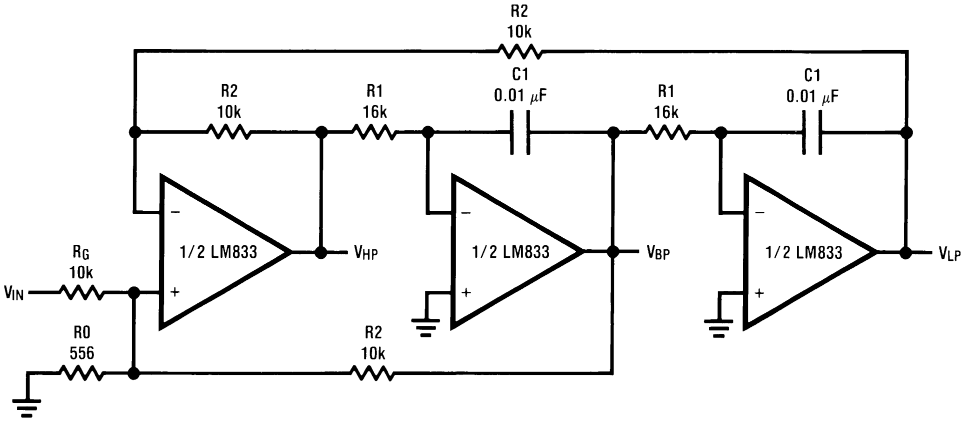
$$C1 = \frac{\sqrt{2}}{\omega_0 R}$$

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

Illustration is f_0 = 1 kHz

Typical Applications (Continued)

State Variable Filter



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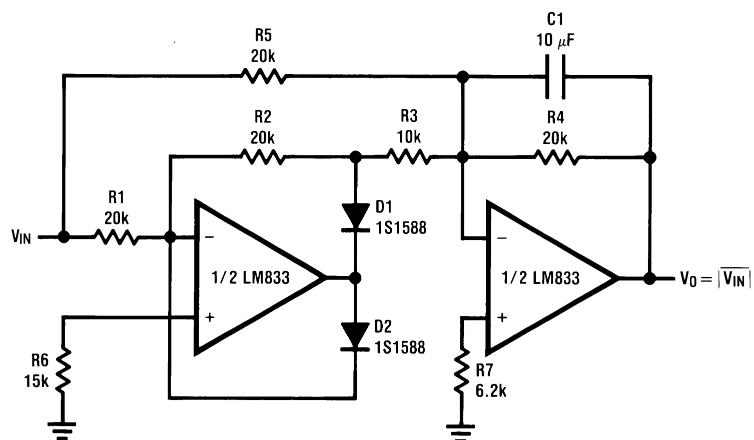
$$f_0 = \frac{1}{2\pi C1R1}, Q = \frac{1}{2}\left(1 + \frac{R2}{R0} + \frac{R2}{RG}\right), A_{BP} = QA_{LP} = QA_{LH} = \frac{R2}{RG}$$

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

AC/DC Converter



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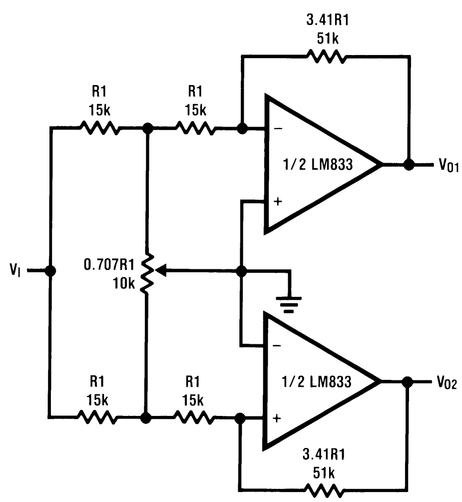
2 Channel Panning Circuit (Pan Pot)



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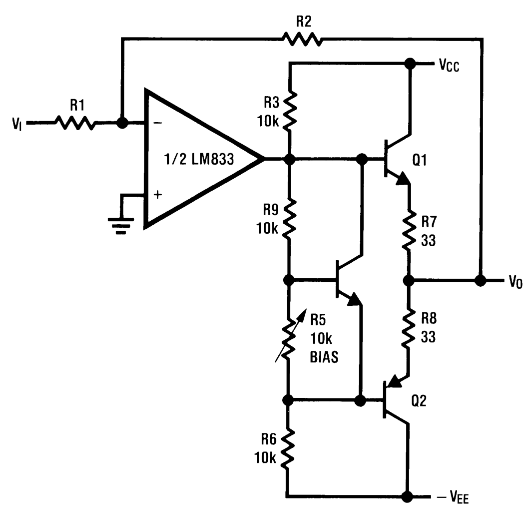
Line Driver



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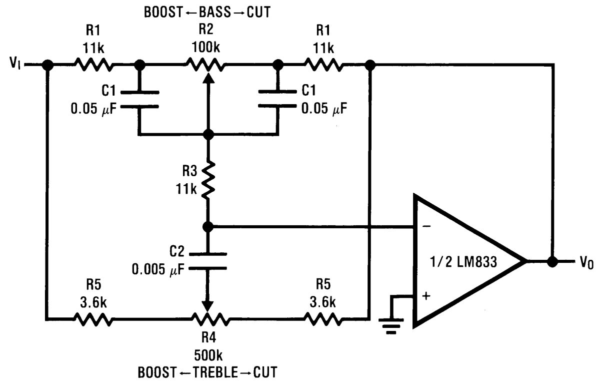
Typical Applications (Continued)

Tone Control



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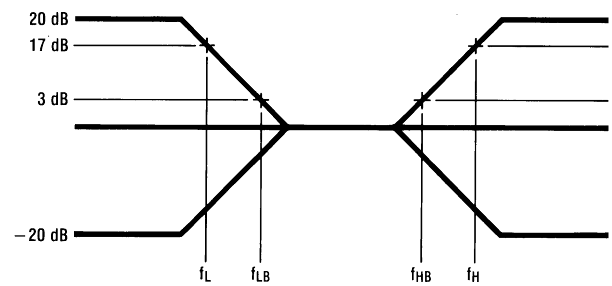
$$f_L = \frac{1}{2\pi R2C1},\ f_{LB} = \frac{1}{2\pi R1C1}$$

$$f_H = \frac{1}{2\pi R5C2},\ f_{HB} = \frac{1}{2\pi (R1 + R5 + 2R3)C2}$$

Illustration is:

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



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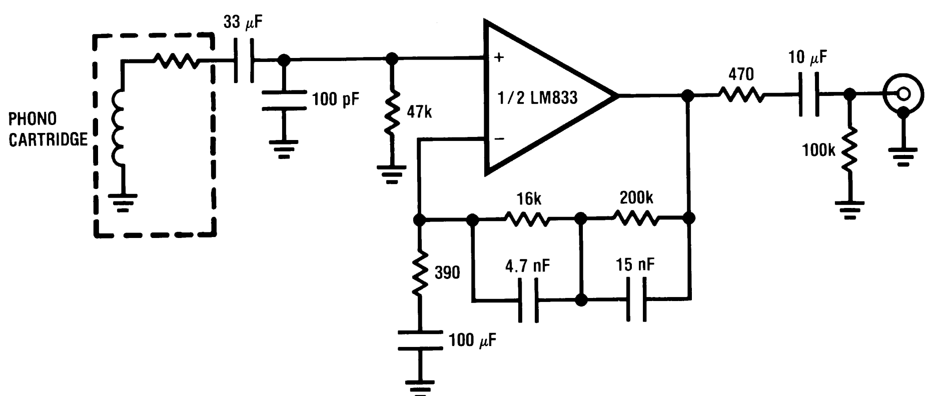
RIAA Preamp



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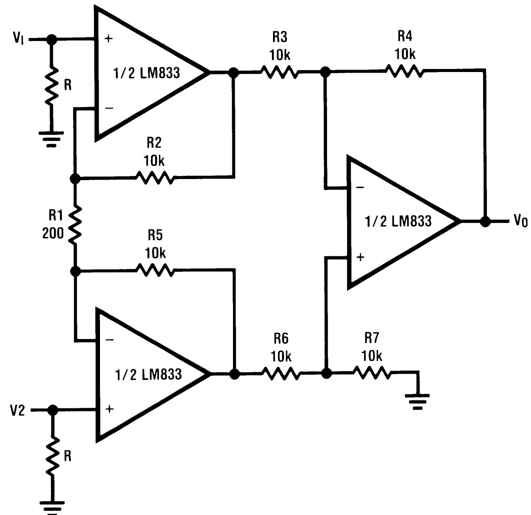
A_v = 35 dB
E_n = 0.33 μV
S/N = 90 dB
f = 1 kHz
A Weighted
A Weighted, V_{IN} = 10 mV
@f = 1 kHz

Typical Applications (Continued)

Balanced Input Mic Amp



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

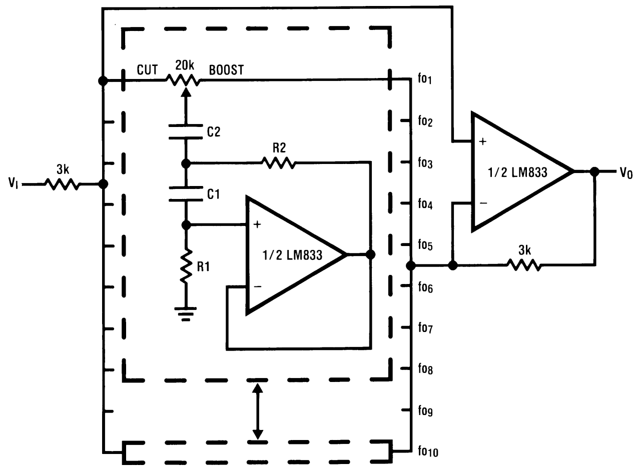
$$V0 = \left(1 + \frac{2R2}{R1}\right)\frac{R4}{R3}(V2 - V1)$$

Illustration is:

V0 = 101(V2 − V1)

Typical Applications (Continued)

10 Band Graphic Equalizer



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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 6: At volume of change = ±12 dB
Q = 1.7

Reference: “AUDIO/RADIO HANDBOOK”, National Semiconductor, 1980, Page 2–61