LM833

40W×2家用高保真合并式放大器

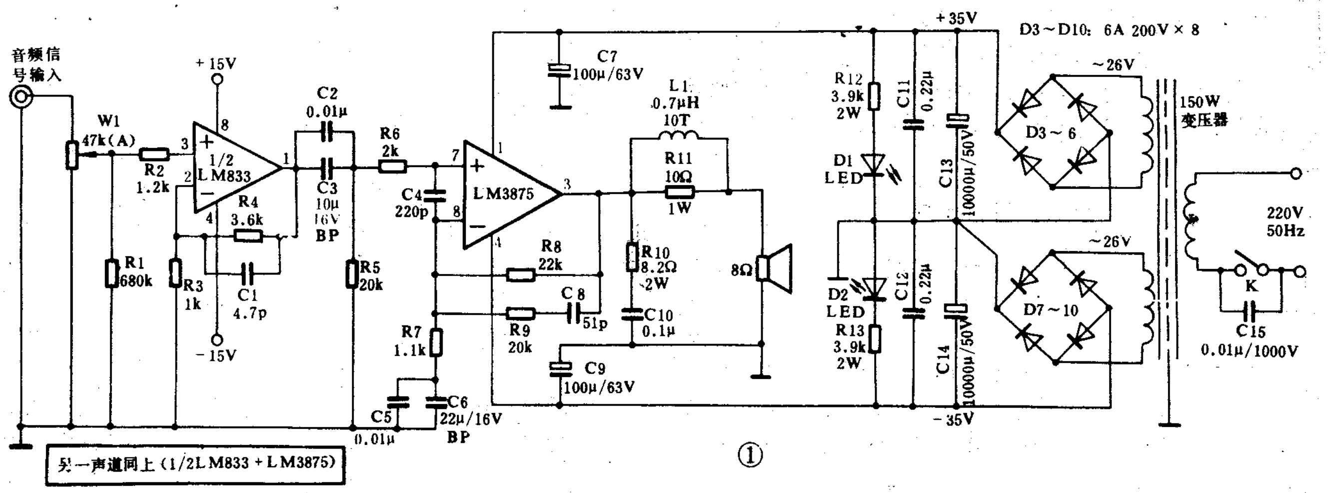
●吴 刚●

美国国家半导体有限公司(简称NSC公司)推出了一系列音响集成电路，其中单片集成功率放大器LM3875(及LM3876)颇引人注目。它是发烧友所熟悉的LM1875升级产品，具有很高性能指标。它在20Hz～20kHz频率范围内，在负载为8Ω时，可连续输出40W以上的平均功率，但谐波失真(THD)只有0.05%。另外，芯片内部具有完善的过压、欠压、过载、电源短路、热击穿以及瞬时高温冲击等保护功能，性能优于一般分立元件和混合器件组装的放大器，而且外围电路简单，装配方便。

为了制作一台音色好的合并式集成电路放大器，笔者选择了LM833做LM3875的最佳搭配。由单片集成电路构成的合并式放大器整机电原理图如图1所示。在电源V＝±35V，负载R_L＝8Ω的情况下，LM3875的电气特性列于表1。LM833的电气特性(T_A＝25℃，Ve＝±15V)见表2。LM3875和LM833的引脚功能见图2。

电路设计

自激振荡是单片集成功放易犯的通病，这给许多发烧友留下的印象是：单片集成功放放出来的声音是典型的晶体管声，中低音缺少弹性，高音发毛刺耳。究其原因是多方面的，其中日本芯片声底薄、细，音色偏冷；美国及欧洲芯片声底厚些，力度较强劲，音色偏暖。除了芯片本身的品质外，还要看印刷电路板的设计水平以及周边元件的选择、匹配和电路的调试。从该40W×2合并式功放来看，输入灵敏度设计在200mV，能适合多种信号源的输入选择。面对当今流行的CD唱机、DAT、MD、DCC等数码音源，放音系统必需具备对数码声有



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计划。日本政府于1994年通过了一项7万户计划，由国家向7万个家庭提供补贴，帮助他们安装太阳能设备。德国正在实施"1000套工程"。对于自给有余的电力，可由家庭输送给公共电网，政府以高价收购。德国于1994年建成一座能源自给住宅。它靠巨大玻璃窗吸纳太阳能，又借助36m²太阳能电池获得电能，利用电能将水电解，获得氢气和氧气，供用户烧水做饭。太阳能热水器为用户供应热水。这样，这座住宅完全不需人为提供能源。

氢能被视为有前景的无污染能源。为获得氢气，需要使用电力，将水电解成氢气与氧气。日本是个岛国，陆地面积有限。它决定在赤道太平洋上建造人工岛，用太阳能电池获得86万千瓦的电力，再用电力制得氢气，经液化后送回日本，代替石油、天然气作为能源。

中国：抓住机遇

在中国，通信业是发展最快的行业之一。

按计划，"八五"期间将建成22条国家一级光缆干线。1994年3月，西(安)成(都)光缆开通并试运行；6月，京沈哈光缆工程的东线(京津沈长哈)开通并试运行；6月底，西(安)兰(州)乌(乌鲁木齐)光缆工程兰乌段光缆接续已完成。

"九五"期间，将建成"八纵八横"光缆网，形成覆盖大中城市的高速传输网络。

目前，国内和国际的海底光缆也在建设中。中国的第一条国际海底光缆已建成。此外，国内卫星地球站二期工程于1994年内建成并试运营，19个省（市、区）联入网内。

中国正在建设金桥、金关、金卡（"三金"）工程。正在执行的"863计划"通信主题的目标，实际上就体现了信息高速公路的主要特征。■

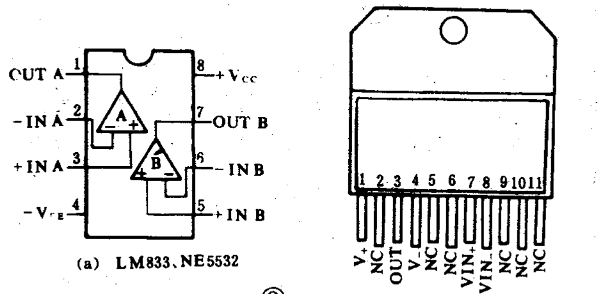
表1

符号	参数	测试条件	典型值	单位
$V_+ + V_-$	电源电压		70	V
Po	输出平均功率	THD+N=0.1% f=1kHz	56	W
PeackPo	瞬时峰值功率		100	W
THD+N	全谐波失真加噪声	40W,20Hz≤f ≤20kHz,Av=26dB	0.05	%
SR	转换速度	Vin=1.41Vrms, f=10kHz 方波,R_L=2Ω	11	V/μs
I_+	静态电流	Vcm=0V,Vo=0V Io=0mA	30	mA
CMRR	共模抑制比	V_+=60→20V V_-=−20→−60V Vcm=20→−20V Io=0mA	120	dB
A_{VOL}	开环电压增益	V_+=V_-=40V R_L=2kΩ,ΔVo=60V	120	dB
GBWP	增益带宽积	V_+=V_-=40V fo=100kHz Vin=50mVrms	8	MHz
SNR	信噪比	Po=40W,A 加权, 1kHz,Rs=25Ω	114	dB

注:LM3875 的外壳与④脚(V_-)相通,使用时请注意。

柔化效果,使"发毛"、"刺耳"声温柔化,把干硬声音乐化。因此,要在设计与选料方面进行全面考虑。首先是考虑放大器的整体电压增益,它对音色影响较大。功率芯片LM3875的增益不可设计过高,因为设计过高有可能使高频响应变差,噪声增大,易引起自激振荡;相反,若增益过小,虽然稳定性提高,但负反馈深度过深,这是造成音色干硬的主要原因。于是,许多资深的发烧友只能靠自己的金耳朵收声。笔者经过测试及对比试听,将LM3875的增益暂定为23倍,约20log23≈27dB。前置放大器LM833性能指标与NE5532不相上下(见表2),已被许多音响厂家所采用,只是缺少广告性的宣传,知名度还不如NE5532。它在人声和小提琴弦乐方面表现得圆润、细腻,较NE5532出色,说明其瞬态失真这项指标颇佳。从方波特性响应来看,20kHz 的方波经LM833构成的十倍放大器输出后,其上冲值小于NE5532的上冲值。前置放大器LM833的增益取得不高,约为4倍多,将200mV 的信号放大后就是近1V 的信号,可驱动功放 LM3875达满功率。前置增益取得过高,信号放大后势必造成功放后级输入信号过载,产生瞬态失真;将大部分增益留给功放LM3875来完成,则可使大信号时输入端无削波失真现象。

在输入阻抗方面,高的输入阻抗对信号源有利,但考虑到LM833的输入端是晶体管,不是场效应管,输入阻抗一般在几十千欧至几百千欧之间,需选用的音量电位器为47kΩ 或33kΩ 的即可。接地采用一点接地法,功率地与信号地需分别走线,按星形接地接到一点。电路布线采用计算机CAD软件设计绘制。功率输出端及整流滤波等强电端尽可能



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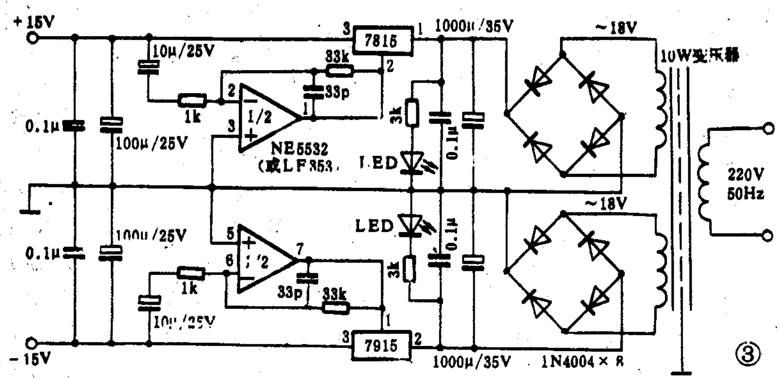
远离信号输入端。前置LM833及功放LM3875分别采用两组独立的正负电源供电。前置放大器LM833供电部分采用双桥整流、进口"红宝石"电解电容滤波,并采用低噪声直流伺服稳压电源(见图3),以便将噪声及纹波降到最低。

元器件选择

功放LM3875及前置LM833均用美国NSC公司原装芯片,质量上没有问题。关键是周边元件的品质对音质起很大影响。耦合电容对频响低端和高端均有影响,故C3选用日本松下公司或ELNA公司产无极性铝电解电容,再并联上一只小容量无感CBB电容以通高频。有条件者C3可选用法国SOLEN 4.7μF/400V 金属化聚丙稀电容。功放整流部分采用6A/400V 整流管做低噪声双桥式整流,功放级滤波电容对音质影响较大,采用两只日本"木石"(marcom)或"红宝石"(Rubycon)10000μF/50V 电解电容,其它电解电容采用日本"木石"(marcom)牌即可。无极性电容均采用北京无线电元件

表2

符号	参数	条件	典型值		单位
			LM833	NE5532	
Av	电压增益	R_L=2kΩ Vo=±10V	110	110	dB
CMRR	共模抑制比	V_{IN}=±12V	100	100	dB
Io	电源电流	Vo=0V BothAmps	5	8	mA
SR	压摆率	R_L=2kΩ	7	9	V/μs
GBWP	增益带宽积	R_L=2kΩ f=100kHz	15	10	MHz
THD	全谐波失真	R_L=2kΩ,f=20 Hz~20kHz,Av=1	0.002	0.004	%
en	最小噪声电压	Rs=100Ω,f=1kHz	4.5	5	nV/Hz
Vos	输入补偿电压	Rs=10Ω	0.3	0.5	mV



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魅力十足的发烧运放NJM2114

笔者向发烧友推荐又一款发烧运放——NJM2114，性能见下表，它的某些指标竟还高过名运放LT1057。

它可谓集“运放皇”NE5532和NE5535的优点于一身，且可直接代换。本人用它在CD唱机上与“运放皇”作同等条件的对比监听，明显感觉耳目一新，音质更清纯，层次更分明，解析力、音像定位特别出色，胜过“运放皇”。乐器、人声的还原可谓逼真传神，原汁原味的感觉真令人回味无穷。

NJM2114运放系日本原装，零售价约2美元，比起那些昂贵运放可谓物超所值。NJM2144的封装型式有双列和单列两种，双列8脚封装引脚与NE5532等相同。本人将NJM2114与NE5532在CD唱机上配合使用，前者用于缓冲放大，后者用于耳机放大，配上SONY MDR系列优质耳机，放张发烧碟，听得飘飘然，如痴如醉。两款运放可谓完美配合，如用在卡座上定增色万分。

□ 珠海 马建雄

著名双运放IC主要特性对比（VS=±15V，Ta=25℃）

型号	输入噪声	增益带宽(MHz)	转换速率SR(V/μs)	电源电压(V)	消耗电流(mA)	厂商
NJM2114	3.3nv/Hz(1KHz)	13	15	±3～±22	9	JRC(日)
LT1057	13nv/Hz(1KHz)	5	14	±12～±25	3.2	LT(美)
NE5535	30nv/Hz(1KHz)	1	15	±12～±25	3.6	SIGNETICS(美)
NE5532	5nv/Hz(1KHz)	10	8	±3～±20	8	SEGNETICS(美)
LM833	4.5nv/Hz(1KHz)	15	8	±5～±20	4	NS(美)

LM833和LM837高保真运放介绍

美国国家半导体公司生产的LM833(双运放)和LM837(四运放)都是特别着重考虑在高保真音频系统应用的大动态,高速率,低噪声,低失真运算放大器。其性能完全可与NE5532,NE5534等相媲美。

LM833双运放早已为广大音响爱好者熟悉。LM833内部采用了新的电路和处理技术,因此可在不增加外围元件和降低稳定性的条件下实现了低噪声,高速率和宽带等优良性能。LM833有普通双列直插封装(型号为LM833N)和超小型封装(SO封装,型号为LM833M)两种外型。它的引脚如图1所示。LM833的主要性能如下:电源电压范围:±5V~±15V,动态范围:>140dB,输入噪声电压:$4.5nV/\sqrt{Hz}$(典型值),转换速率:7V/μs,增益带宽:15MHz,失真度:0.002%。

从以上性能可看出用LM833可做出性能优异的Hi-Fi放大器。它的性能见表1。

LM837除了具有LM833的优点外,它还具有功耗大(双列直插封装的LM837N可达1.2W),输出电流可达±40mA,可直接驱动600Ω负载,因此用LM837可设计制作标准输出的Hi-Fi前置放大器或直接驱动功放管。LM837的引脚如图2所示,它也有超小型封装(SO封装,型号为LM837M)。LM837为四运放。转换速率比LM833还高,达10V/μs,增益带宽达25MHz。LN837的性能参数见表2。用LM837可设计制作数字音频系统,图示均衡器,HI-Fi前置放大器伺服电源等等。

□四川　古文

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LM833

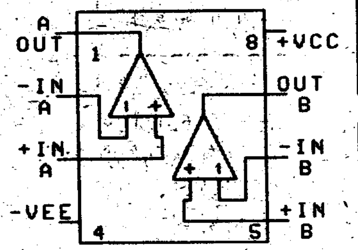

表1　$T_A=25℃$　$Vs=\pm15V$

参　数	测试条件	典型值
电源电压范围		±5~±15V
输入失调电压	Rs=10Ω	0.3mV
输入失调电流		10nA
输入偏置电流		500nA
电压增益	$R_L=2kΩ$ $V_o=\pm10V$	110dB
输出电压摆幅	$R_L=10kΩ$　$R_L=2kΩ$	±13.5V ±13.4V
共模输入电压范围		±14.0V
共模抑制比	Vin=±12V	100dB
电源抑制比	Vs=15~5V,-15~-5V	100dB
电源电流	V_O=0V,两个运放	5mA
转换速率	$R_L=2kΩ$	7V/μs
增益带宽乘积	f=100kHz	15MHz
失真度*	R_L=2KΩ,f=20~20KHz VouT=3Vrms,Av=1	0.002%
输入失调电压的平均温度系数*		2μV/℃
输入噪声电压*	Rs=100Ω,f=1kHz	$4.5n/\sqrt{Hz}$
输入噪声电流*	f=1kHz	$0.7p/\sqrt{Hz}$
功率带宽*	V0=27Vp-p, RL=2kΩ,THD≤1%	120kHz

* 此项指标不测试。

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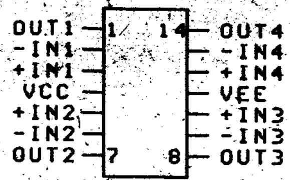

1、最大允许范围

电源电压	V_{CC}/V_{EE}	±18V
差动输入电压	V_{ID}	±30V
共模输入电压	V_{IC}	±15V
功耗	P_D	1.2 W(LM837N) 0.83 W(LM837M)
工作温度范围	T_{opR}	-40~+85℃

2、直流电性能

符号	参数	测试条件	典型值
V_O	输入失调电压	Rs=50Ω	0.3mV
Ios	输入失调电流		10nA
I_B	输入偏流		500nA
Av	大信号电压增益	$R_L=2kΩ$ $V_{OUT}=\pm10V$	110 dB
V_{OM}	输出电压摆幅	$R_L=2kΩ$	±13.5V
		$R_L=600Ω$	±12.5V
V_{CM}	共模输入电压		±14.0V
CMRR	共模抑制比	$V_{IN}=\pm12V$	100dB
PSRR	电源抑制比	V_S=15~5V -15~-5V	100 dB
Is	电源电流	R_L= ,四运放	10mA

3、交流电性能

符号	参数	测试条件	典型值
SR	转换速率	$R_L=600Ω$	10V/μs
GBW	增益带宽乘积	f=100kHz $R_L=600Ω$	25 MHz

4、其它参数*

符号	参数	测试条件	典型值
PBW	功率带宽	V_O=25Vp-p $R_L=600Ω$ THD<1%	200kHz
en1	等效输入噪声电压	JISA	Rs=100Ω
en2		f=1kHz	$4.5nV/\sqrt{Hz}$
THD	总谐波失真	Av=1 VouT=3Vrms f=20~20kHz $R_L=600Ω$	0.0015%

* 本栏参数不测试。

LM833

Dual Low Noise, Audio Amplifier

The LM833 is a standard low–cost monolithic dual general–purpose operational amplifier employing Bipolar technology with innovative high–performance concepts for audio systems applications. With high frequency PNP transistors, the LM833 offers low voltage noise (4.5 nV/$\sqrt{Hz}$), 15 MHz gain bandwidth product, 7.0 V/µs slew rate, 0.3 mV input offset voltage with 2.0 µV/°C temperature coefficient of input offset voltage. The LM833 output stage exhibits no deadband crossover distortion, large output voltage swing, excellent phase and gain margins, low open loop high frequency output impedance and symmetrical source/sink AC frequency response.

For an improved performance dual/quad version, see the MC33079 family.

- Low Voltage Noise: 4.5 nV/$\sqrt{Hz}$
- High Gain Bandwidth Product: 15 MHz
- High Slew Rate: 7.0 V/µs
- Low Input Offset Voltage: 0.3 mV
- Low T.C. of Input Offset Voltage: 2.0 µV/°C
- Low Distortion: 0.002%
- Excellent Frequency Stability
- Dual Supply Operation

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage (V_{CC} to V_{EE})	V_S	+36	V
Input Differential Voltage Range (Note 1.)	V_{IDR}	30	V
Input Voltage Range (Note 1.)	V_{IR}	±15	V
Output Short Circuit Duration (Note 2.)	t_{SC}	Indefinite	
Operating Ambient Temperature Range	T_A	–40 to +85	°C
Operating Junction Temperature	T_J	+150	°C
Storage Temperature	T_{stg}	–60 to +150	°C
Maximum Power Dissipation (Notes 2. and 3.)	P_D	500	mW

1. Either or both input voltages must not exceed the magnitude of V_{CC} or V_{EE}.
2. Power dissipation must be considered to ensure maximum junction temperature (T_J) is not exceeded (see power dissipation performance characteristic).
3. Maximum value at $T_A \leq 85°C$.

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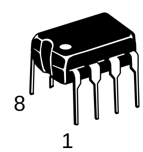
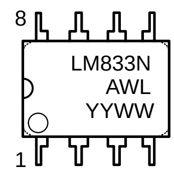
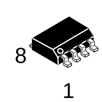
MARKING DIAGRAMS

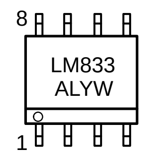


PDIP–8
N SUFFIX
CASE 626



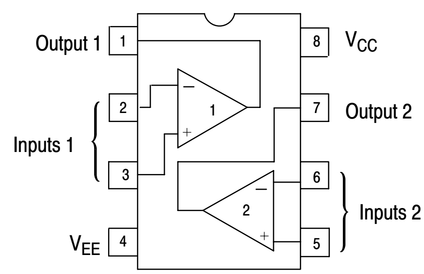


SO–8
D SUFFIX
CASE 751



A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

Device	Package	Shipping
LM833N	PDIP–8	50 Units/Rail
LM833D	SO–8	98 Units/Rail
LM833DR2	SO–8	2500 Tape & Reel

February, 2001 – Rev. 1
Publication Order Number:
LM833/D

ELECTRICAL CHARACTERISTICS (V_{CC} = +15 V, V_{EE} = –15 V, T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Input Offset Voltage (R_S = 10 Ω, V_O = 0 V)	V_{IO}	–	0.3	5.0	mV
Average Temperature Coefficient of Input Offset Voltage R_S = 10 Ω, V_O = 0 V, T_A = T_{low} to T_{high}	$\Delta V_{IO}/\Delta T$	–	2.0	–	μV/°C
Input Offset Current (V_{CM} = 0 V, V_O = 0 V)	I_{IO}	–	10	200	nA
Input Bias Current (V_{CM} = 0 V, V_O = 0 V)	I_{IB}	–	300	1000	nA
Common Mode Input Voltage Range	V_{ICR}	– –12	+14 –14	+12 –	V
Large Signal Voltage Gain (R_L = 2.0 kΩ, V_O = ±10 V	A_{VOL}	90	110	–	dB
Output Voltage Swing: R_L = 2.0 kΩ, V_{ID} = 1.0 V R_L = 2.0 kΩ, V_{ID} = 1.0 V R_L = 10 kΩ, V_{ID} = 1.0 V R_L = 10 kΩ, V_{ID} = 1.0 V	 V_{O+} V_{O-} V_{O+} V_{O-}	 10 – 12 –	 13.7 –14.1 13.9 –14.7	 – –10 – –12	V
Common Mode Rejection (V_{in} = ±12 V)	CMR	80	100	–	dB
Power Supply Rejection (V_S = 15 V to 5.0 V, –15 V to –5.0 V)	PSR	80	115	–	dB
Power Supply Current (V_O = 0 V, Both Amplifiers)	I_D	–	4.0	8.0	mA

AC ELECTRICAL CHARACTERISTICS (V_{CC} = +15 V, V_{EE} = –15 V, T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Slew Rate (V_{in} = –10 V to +10 V, R_L = 2.0 kΩ, A_V = +1.0)	S_R	5.0	7.0	–	V/μs
Gain Bandwidth Product (f = 100 kHz)	GBW	10	15	–	MHz
Unity Gain Frequency (Open Loop)	f_U	–	9.0	–	MHz
Unity Gain Phase Margin (Open Loop)	θ_m	–	60	–	Deg
Equivalent Input Noise Voltage (R_S = 100 Ω, f = 1.0 kHz)	e_n	–	4.5	–	$nV/\sqrt{Hz}$
Equivalent Input Noise Current (f = 1.0 kHz)	i_n	–	0.5	–	$pA/\sqrt{Hz}$
Power Bandwidth (V_O = 27 V_{pp}, R_L = 2.0 kΩ, THD ≤ 1.0%)	BWP	–	120	–	kHz
Distortion (R_L = 2.0 kΩ, f = 20 Hz to 20 kHz, V_O = 3.0 V_{rms}, A_V = +1.0)	THD	–	0.002	–	%
Channel Separation (f = 20 Hz to 20 kHz)	C_S	–	–120	–	dB

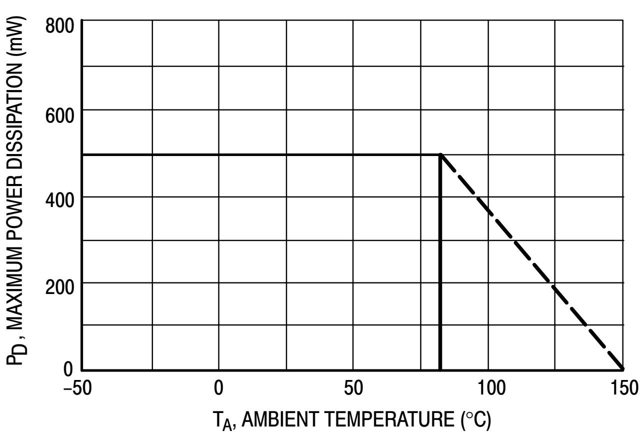


Figure 1. Maximum Power Dissipation versus Temperature

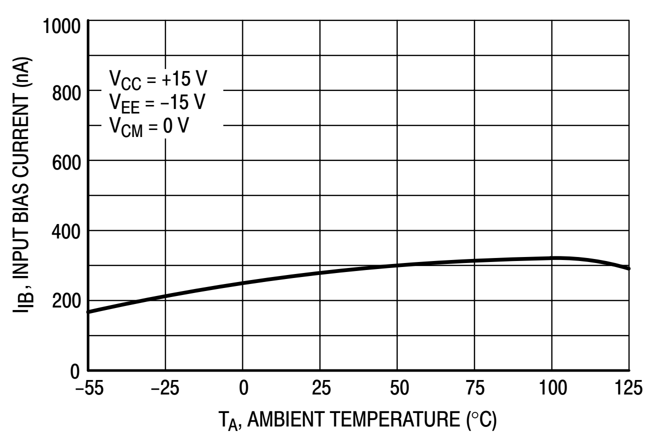


Figure 2. Input Bias Current versus Temperature

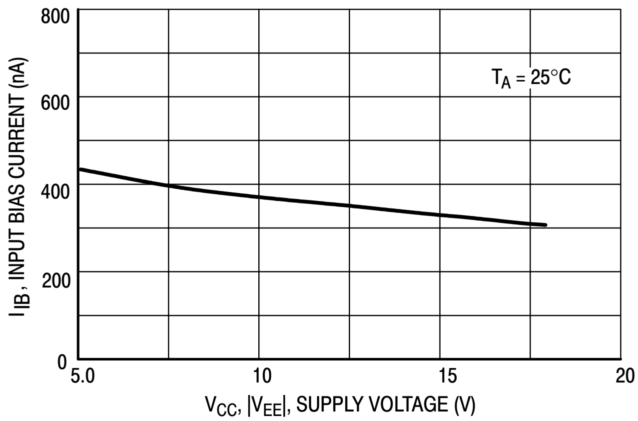


Figure 3. Input Bias Current versus Supply Voltage

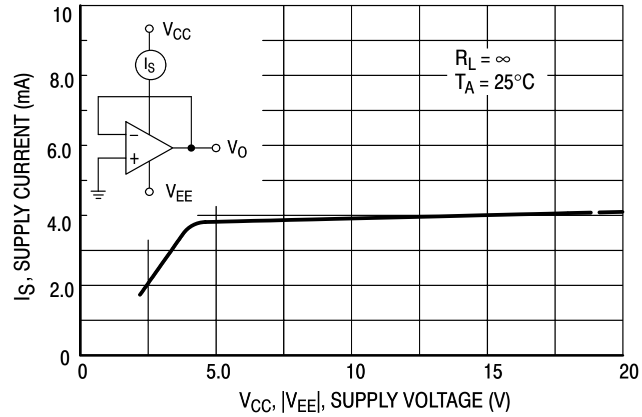


Figure 4. Supply Current versus Supply Voltage

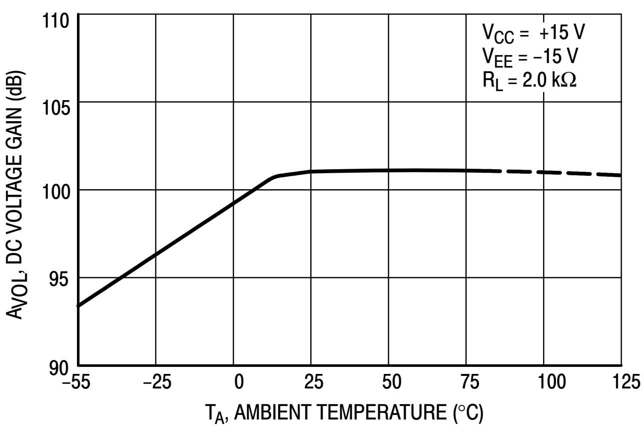


Figure 5. DC Voltage Gain versus Temperature

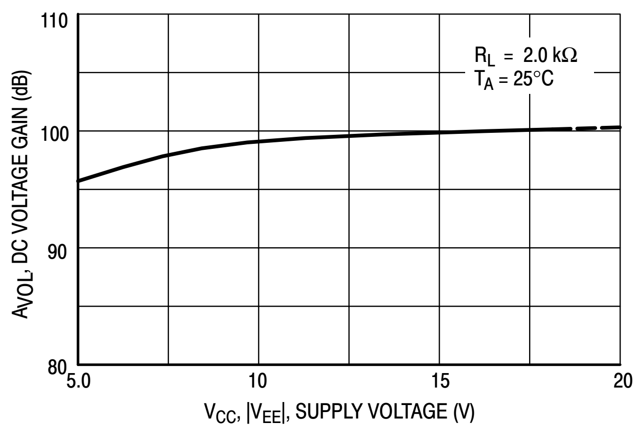


Figure 6. DC Voltage Gain versus Supply Voltage

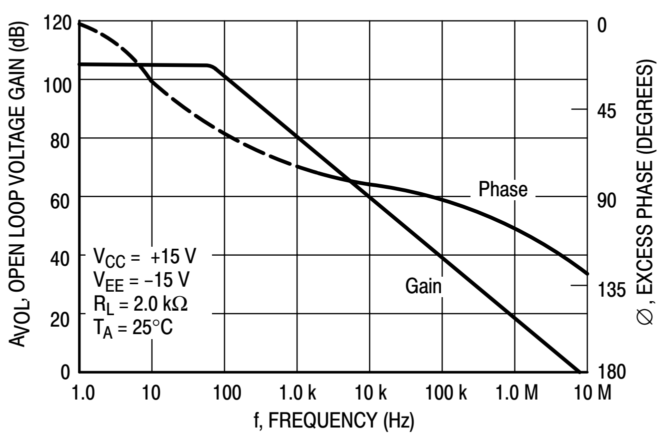


Figure 7. Open Loop Voltage Gain and Phase versus Frequency

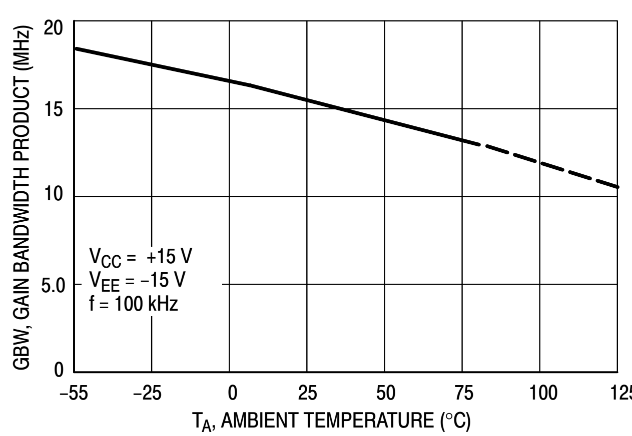


Figure 8. Gain Bandwidth Product versus Temperature

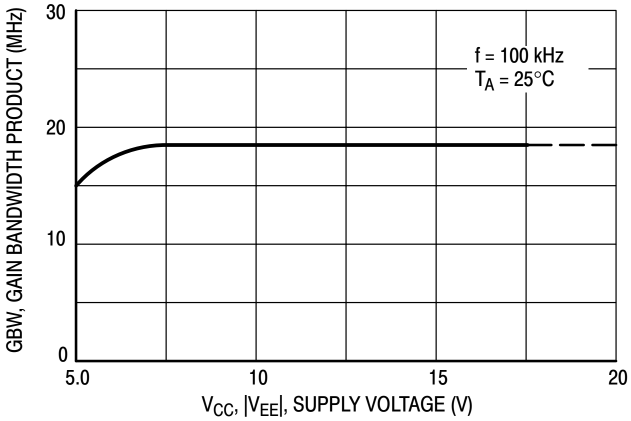


Figure 9. Gain Bandwidth Product versus Supply Voltage

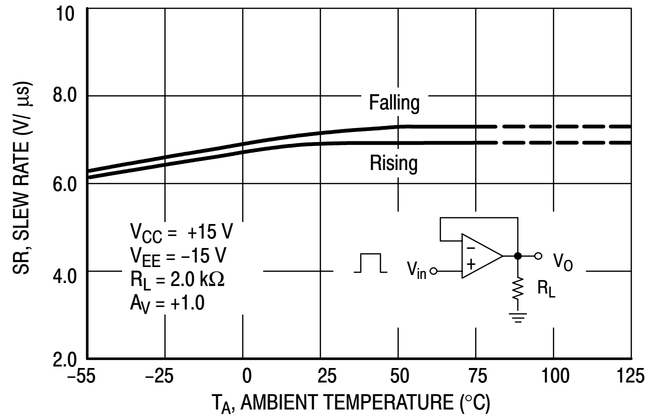


Figure 10. Slew Rate versus Temperature

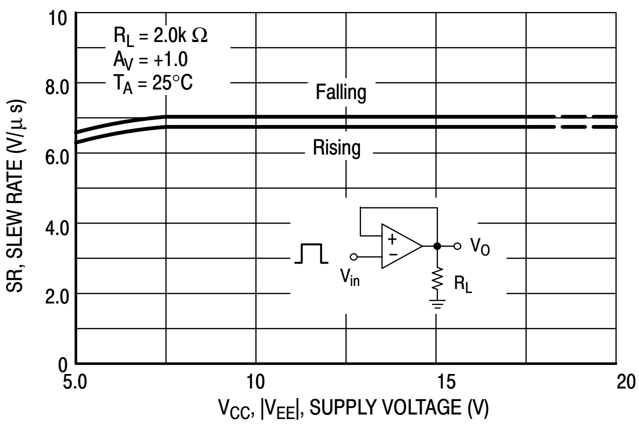


Figure 11. Slew Rate versus Supply Voltage

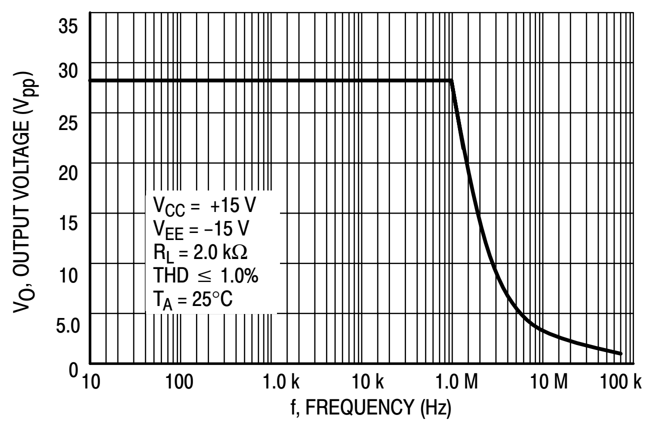


Figure 12. Output Voltage versus Frequency

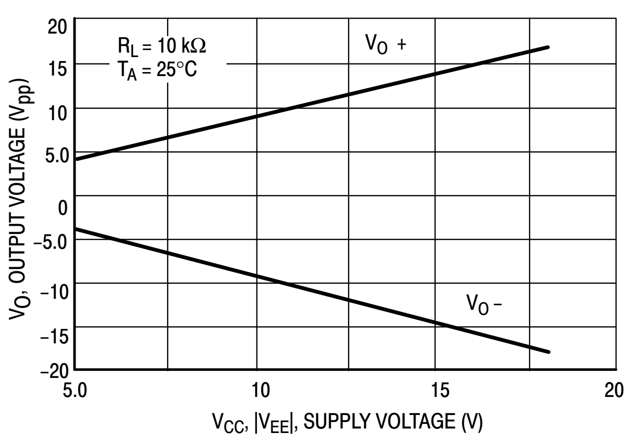


Figure 13. Maximum Output Voltage versus Supply Voltage

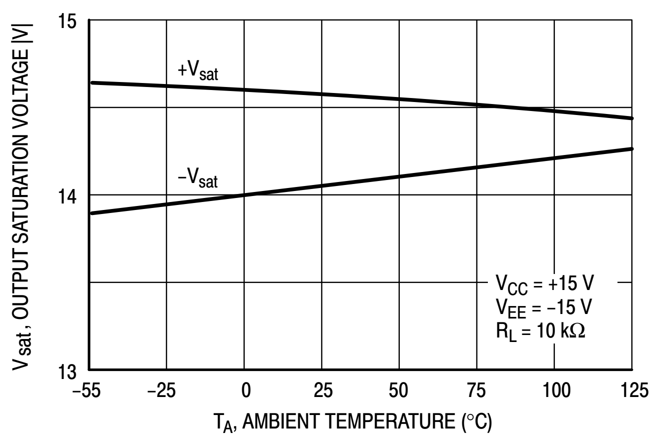


Figure 14. Output Saturation Voltage versus Temperature

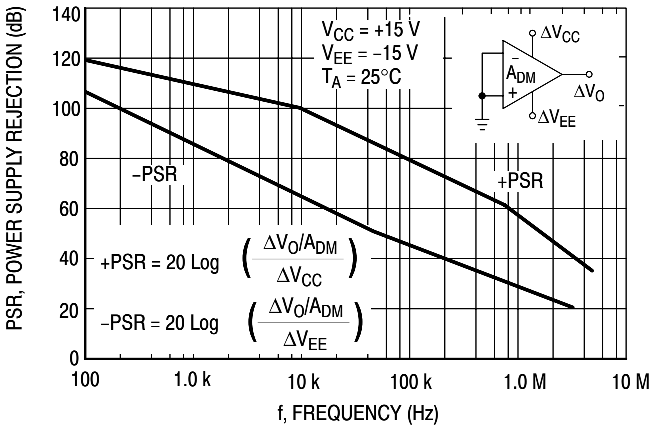


Figure 15. Power Supply Rejection versus Frequency

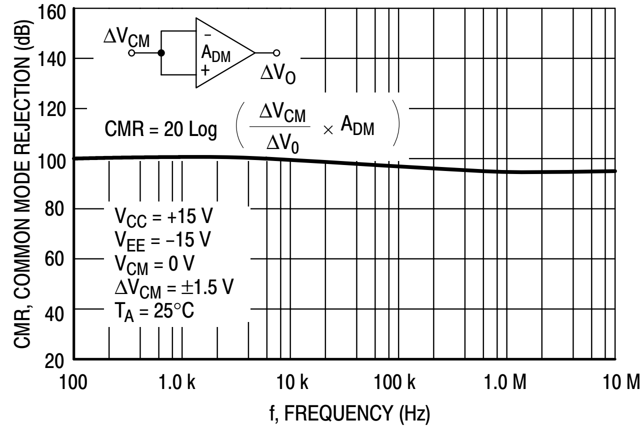


Figure 16. Common Mode Rejection versus Frequency

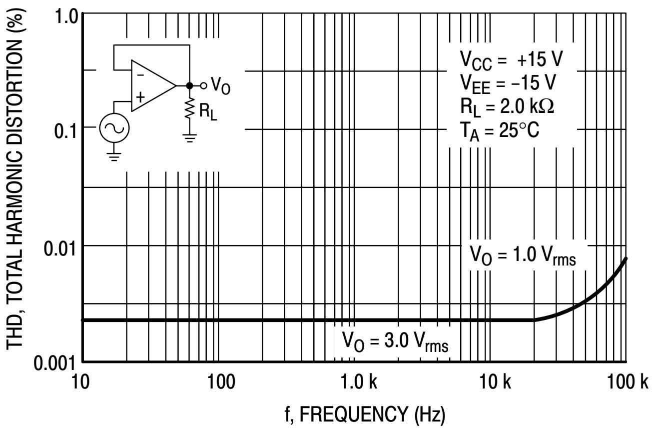


Figure 17. Total Harmonic Distortion versus Frequency

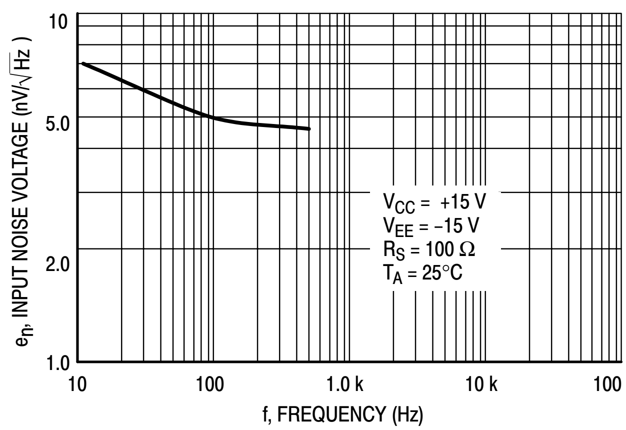


Figure 18. Input Referred Noise Voltage versus Frequency

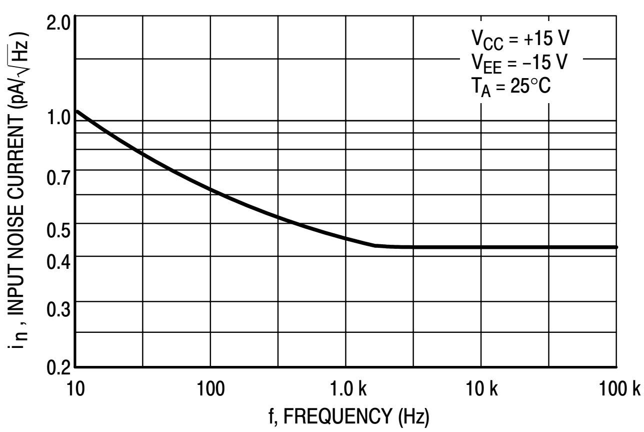


Figure 19. Input Referred Noise Current versus Frequency

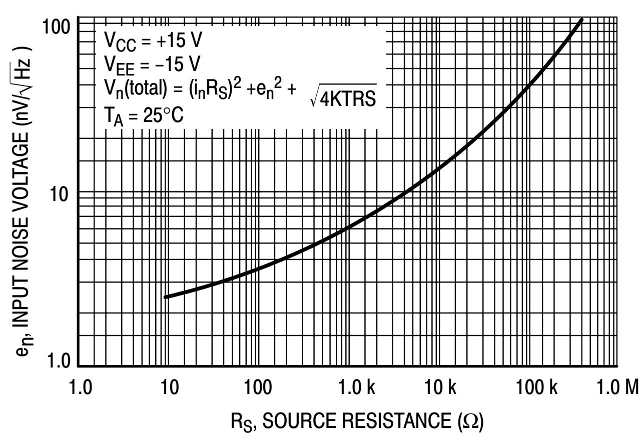


Figure 20. Input Referred Noise Voltage versus Source Resistance

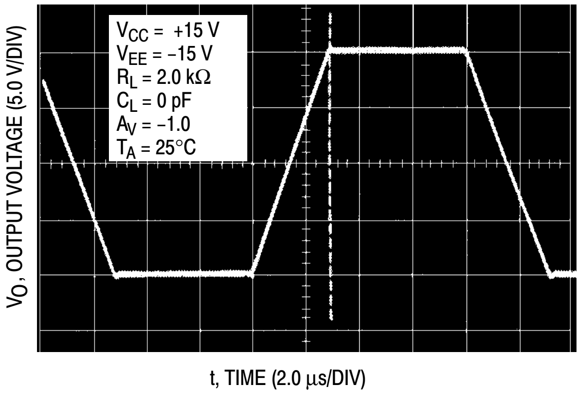


Figure 21. Inverting Amplifier

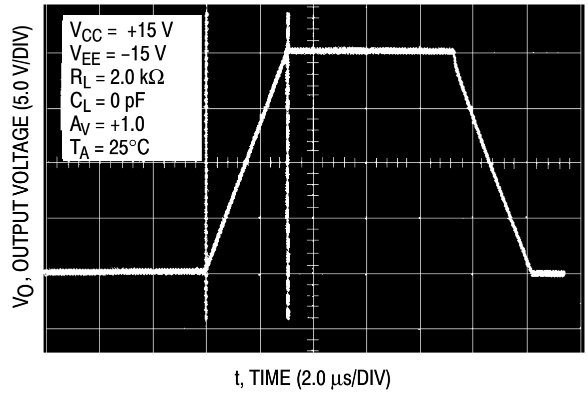


Figure 22. Noninverting Amplifier Slew Rate

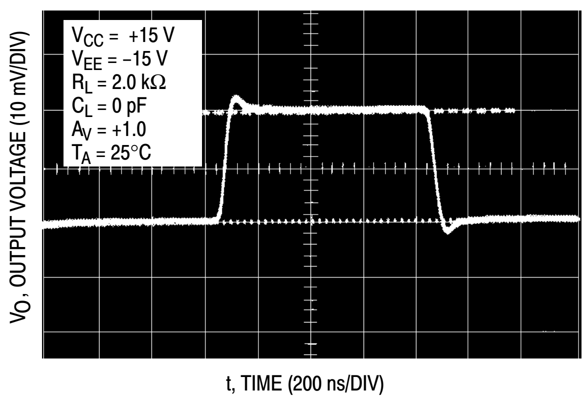
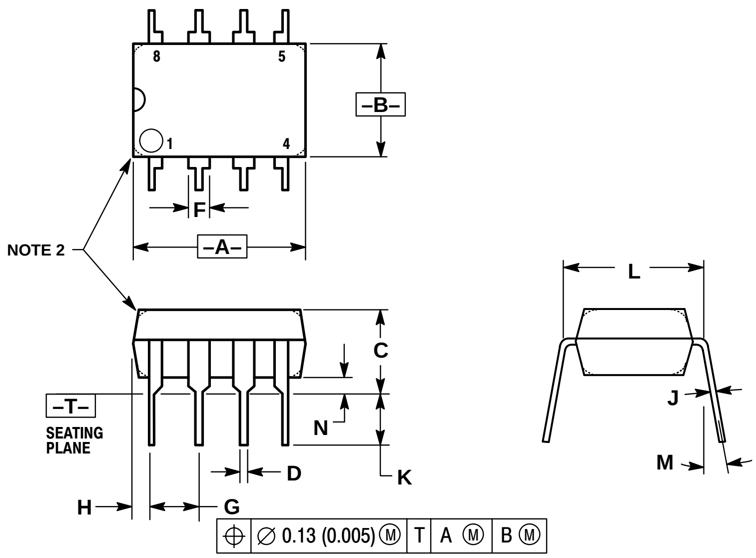


Figure 23. Noninverting Amplifier Overshoot

PACKAGE DIMENSIONS

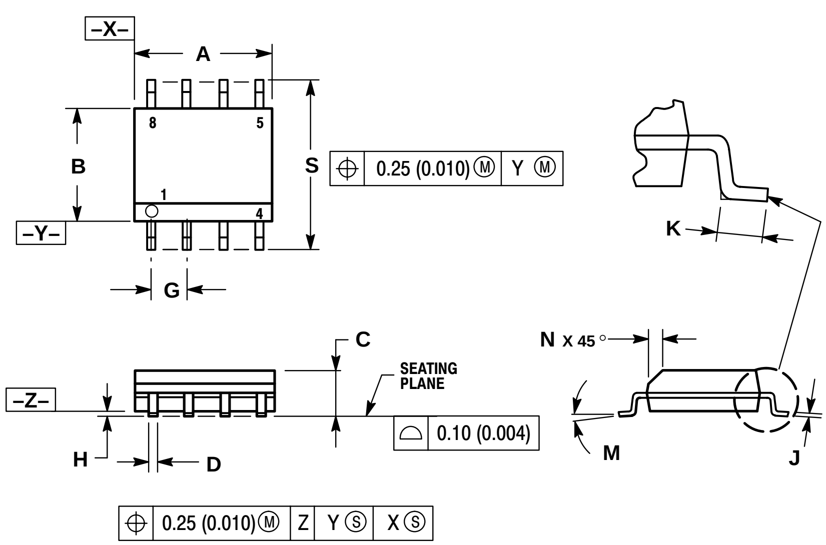
PDIP–8
N SUFFIX
CASE 626–05
ISSUE L



NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	---	10°	---	10°
N	0.76	1.01	0.030	0.040

SO–8
D SUFFIX
CASE 751–07
ISSUE W



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

PUBLICATION ORDERING INFORMATION

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For additional information, please contact your local Sales Representative.

National Semiconductor

August 1997

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.

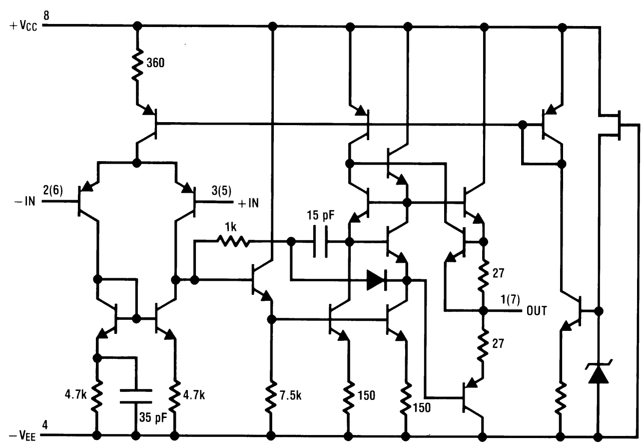
This dual amplifier IC utilizes new circuit and processing techniques to deliver low noise, high speed and wide bandwidth without increasing external components or decreasing stability. The LM833 is internally compensated for all closed loop gains and is therefore optimized for all preamp and high level stages in PCM and HiFi systems.

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

Features

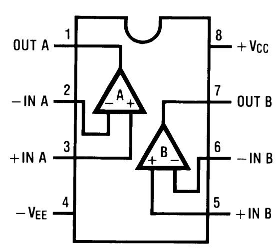
- Wide dynamic range: 140dB
- Low input noise voltage: 4.5nV/√Hz
- High slew rate: 7 V/µs (typ); 5V/µs (min)
- High gain bandwidth: 15MHz (typ); 10MHz (min)
- Wide power bandwidth: 120KHz
- Low distortion: 0.002%
- Low offset voltage: 0.3mV
- Large phase margin: 60˚
- Available in 8 pin MSOP package

Schematic Diagram (1/2 LM833)



DS005218-1

Connection Diagram



DS005218-2

Order Number LM833M, LM833N or LM833MM
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

Design Electrical Characteristics (Continued)

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.

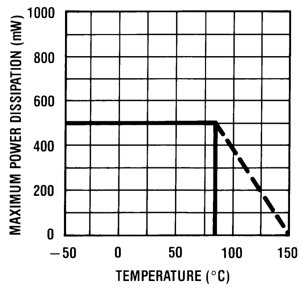
Note 3: If supply voltage is less than ±15V, it is equal to supply voltage.

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

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

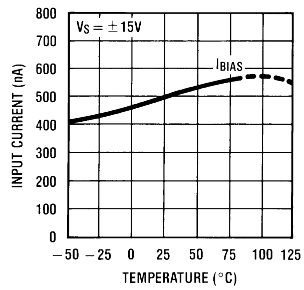
Typical Performance Characteristics

Maximum Power Dissipation vs Ambient Temperature



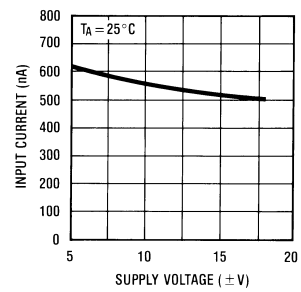
DS005218-4

Input Bias Current vs Ambient Temperature



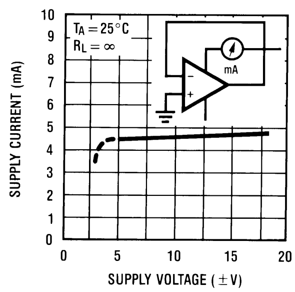
DS005218-5

Input Bias Current vs Supply Voltage



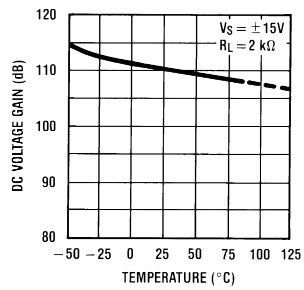
DS005218-6

Supply Current vs Supply Voltage



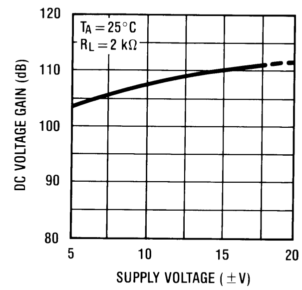
DS005218-7

DC Voltage Gain vs Ambient Temperature



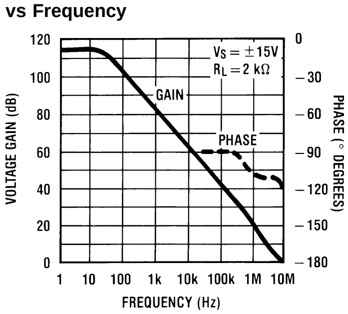
DS005218-8

DC Voltage Gain vs Supply Voltage



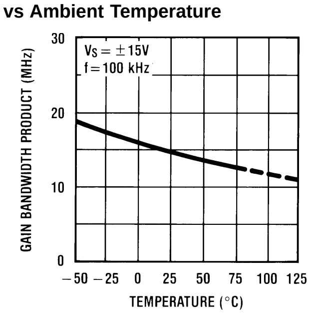
DS005218-9

Voltage Gain & Phase vs Frequency



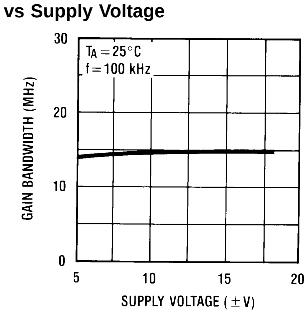
DS005218-10

Gain Bandwidth Product vs Ambient Temperature



DS005218-11

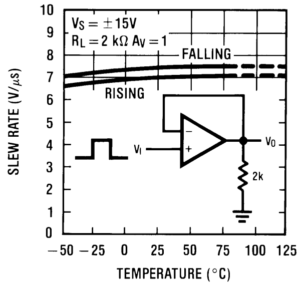
Gain Bandwidth vs Supply Voltage



DS005218-12

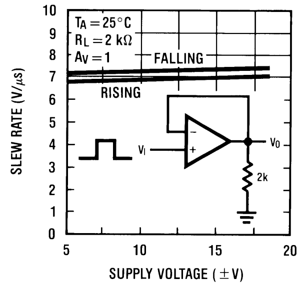
Typical Performance Characteristics (Continued)

Slew Rate vs Ambient Temperature



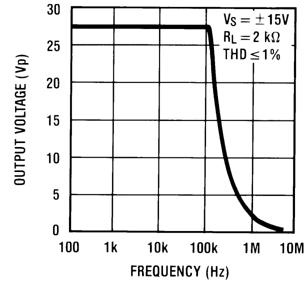
DS005218-13

Slew Rate vs Supply Voltage



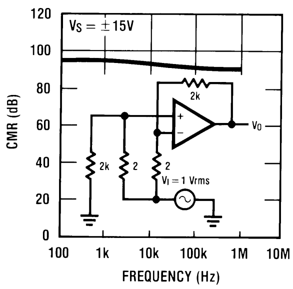
DS005218-14

Power Bandwidth



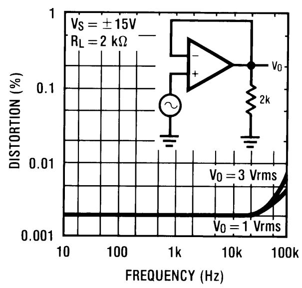
DS005218-15

CMR vs Frequency



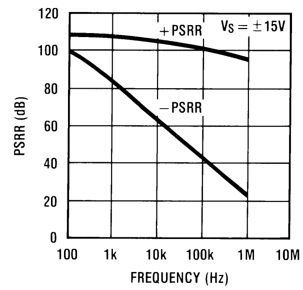
DS005218-19

Distortion vs Frequency



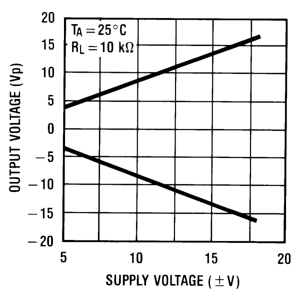
DS005218-20

PSRR vs Frequency



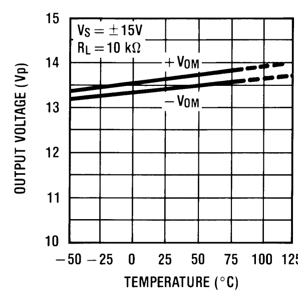
DS005218-18

Maximum Output Voltage vs Supply Voltage



DS005218-16

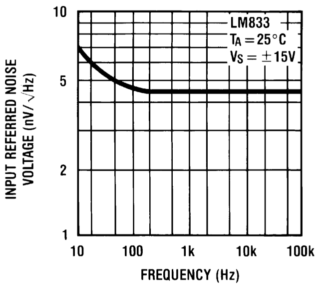
Maximum Output Voltage vs Ambient Temperature



DS005218-17

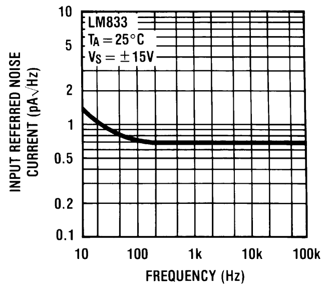
Typical Performance Characteristics (Continued)

Spot Noise Voltage vs Frequency



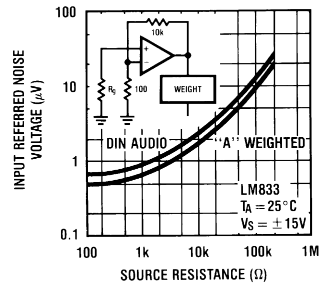
DS005218-21

Spot Noise Current vs Frequency



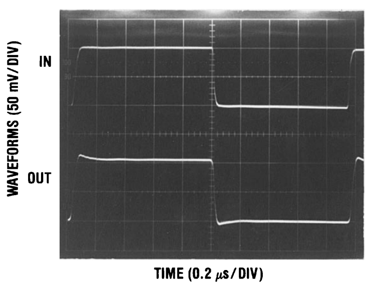
DS005218-22

Input Referred Noise Voltage vs Source Resistance



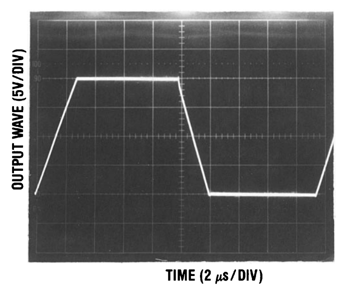
DS005218-23

Noninverting Amp



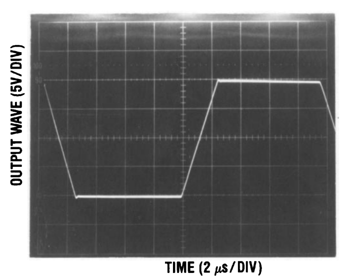
DS005218-24

Noninverting Amp



DS005218-25

Inverting Amp



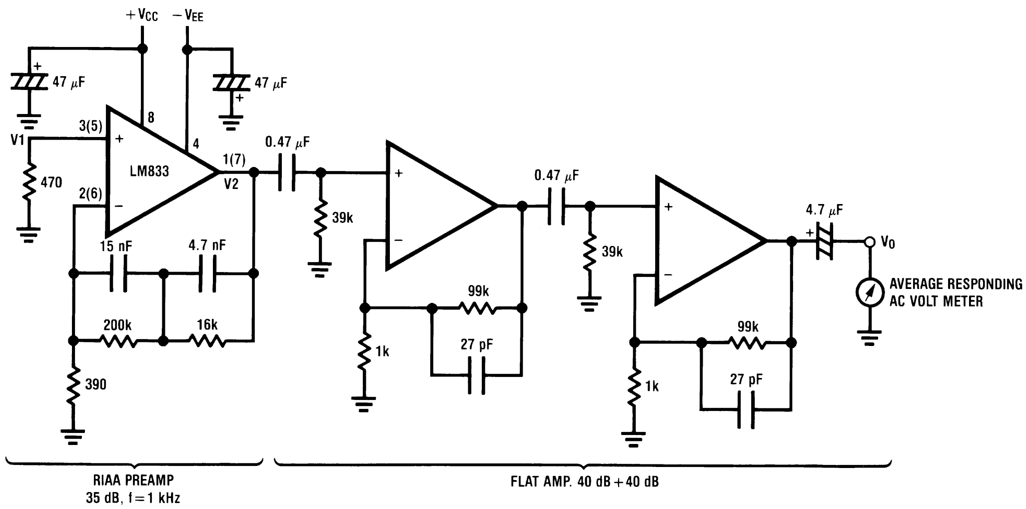
DS005218-26

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



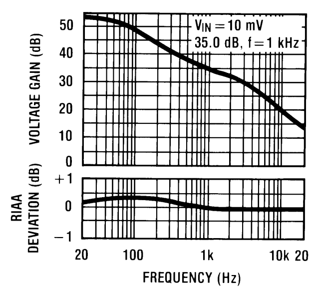
DS005218-27

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

Total Gain: 115 dB @f = 1 kHz

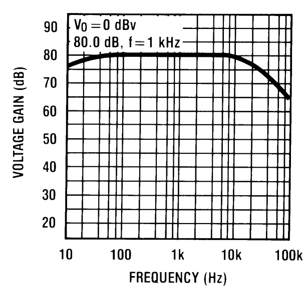
Input Referred Noise Voltage: e_n = V0/560,000 (V)

RIAA Preamp Voltage Gain, RIAA Deviation vs Frequency



DS005218-28

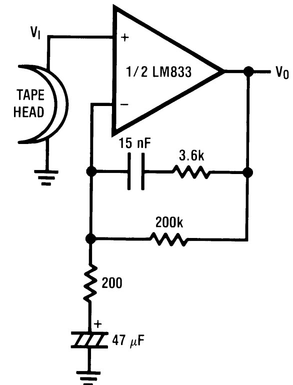
Flat Amp Voltage Gain vs Frequency



DS005218-29

Typical Applications

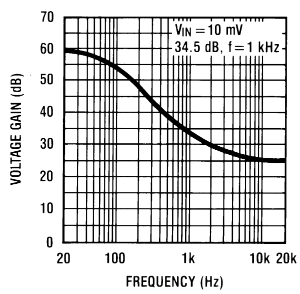
NAB Preamp



DS005218-30

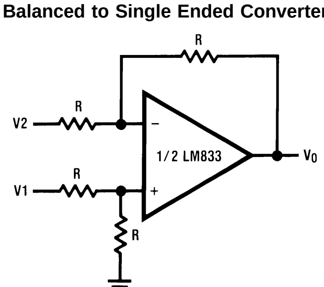
$A_V = 34.5$
F = 1 kHz
$E_n = 0.38\ \mu V$
A Weighted

NAB Preamp Voltage Gain vs Frequency



DS005218-31

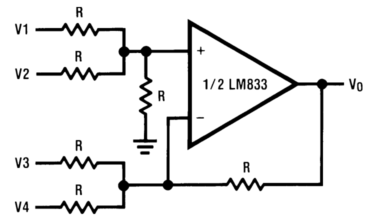
Balanced to Single Ended Converter



DS005218-32

$V_O = V1–V2$

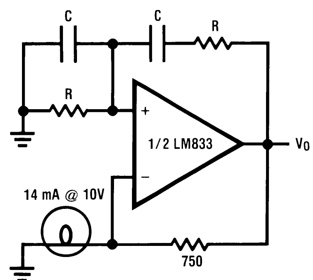
Adder/Subtracter



DS005218-33

$V_O = V1 + V2 − V3 − V4$

Sine Wave Oscillator

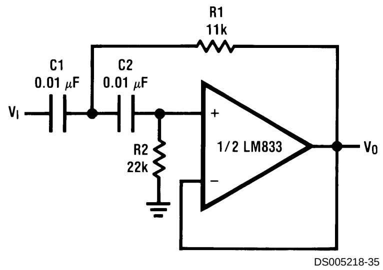


DS005218-34

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

Typical Applications (Continued)

Second Order High Pass Filter (Butterworth)



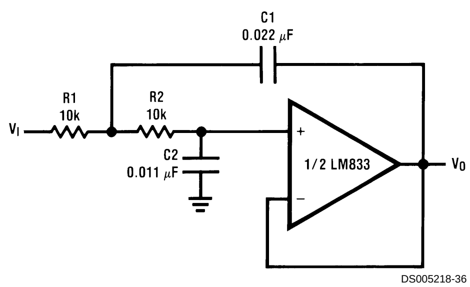
if C1 = C2 = C

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

R2 = 2•R1

Illustration is f_0 = 1 kHz

Second Order Low Pass Filter (Butterworth)



if R1 = R2 = R

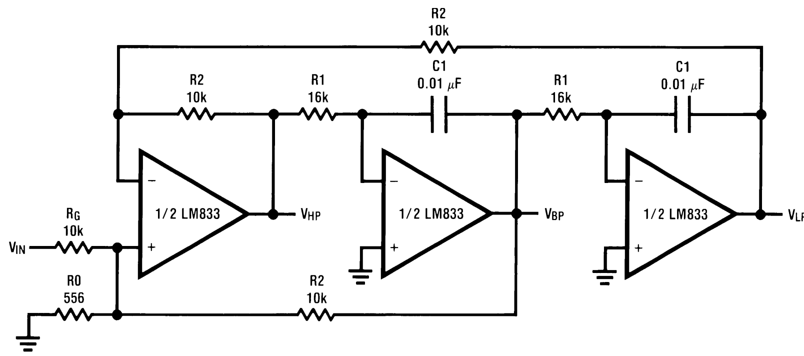
$$C1 = \frac{\sqrt{2}}{\omega_o R}$$

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

Illustration is f_0 = 1 kHz

Typical Applications (Continued)

State Variable Filter

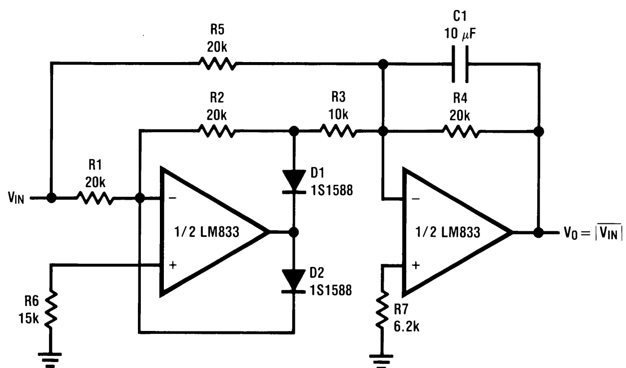


DS005218-37

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

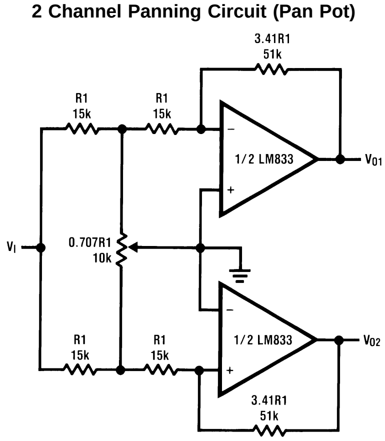
Illustration is f_0 = 1 kHz, Q = 10, A_{BP} = 1

AC/DC Converter



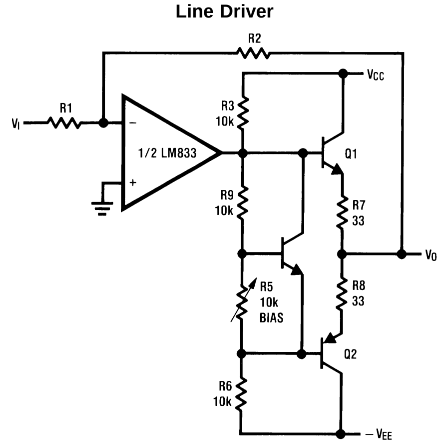
DS005218-38

2 Channel Panning Circuit (Pan Pot)



DS005218-39

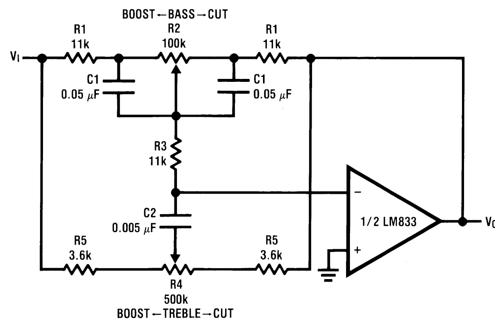
Line Driver



DS005218-40

Typical Applications (Continued)

Tone Control

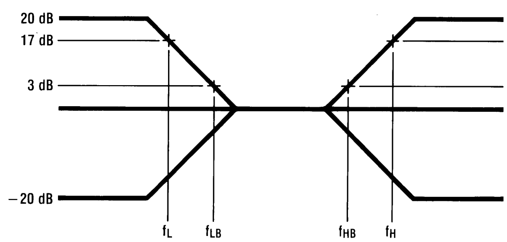


DS005218-41

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

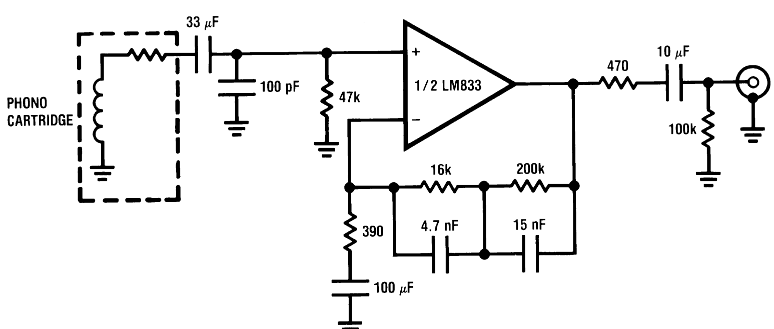
$f_H = \frac{1}{2\pi R5C2}$, $f_{HB} = \frac{1}{2\pi(R1 + R5 + 2R3)C2}$

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



DS005218-42

RIAA Preamp

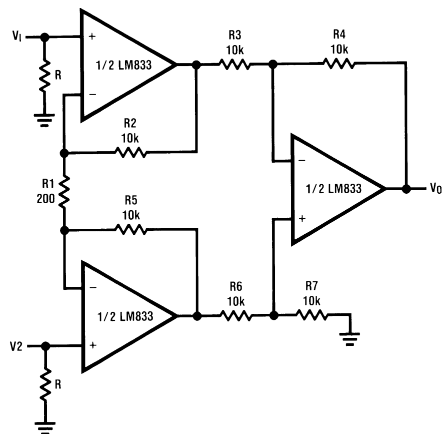


DS005218-3

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



DS005218-43

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

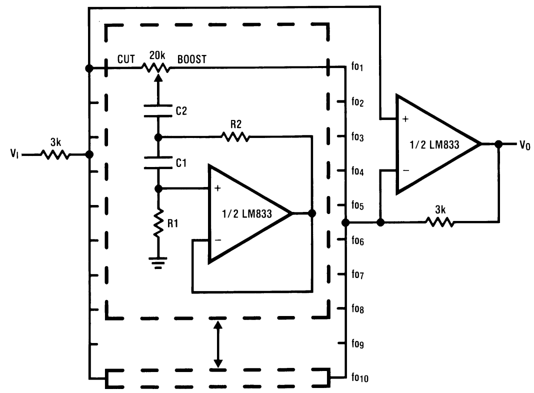
$$V0 = \left(1 + \frac{2R2}{R1}\right)\frac{R4}{R3}(V2 - V1)$$

Illustration is:

V0 = 101(V2 − V1)

Typical Applications (Continued)

10 Band Graphic Equalizer



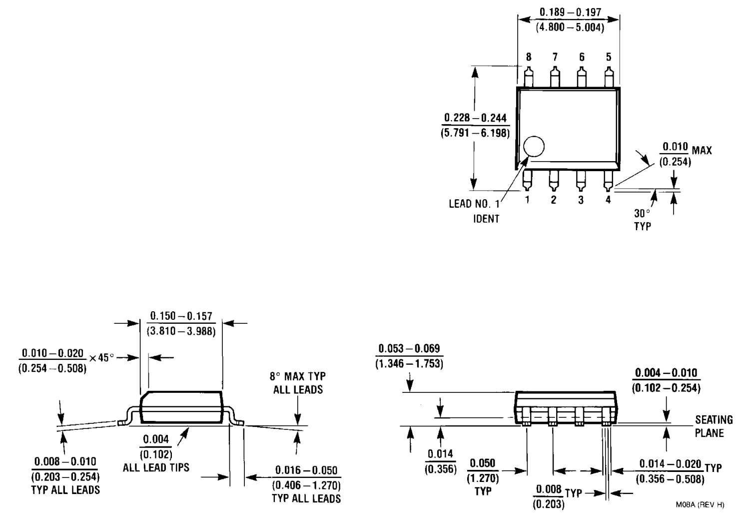
DS005218-44

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

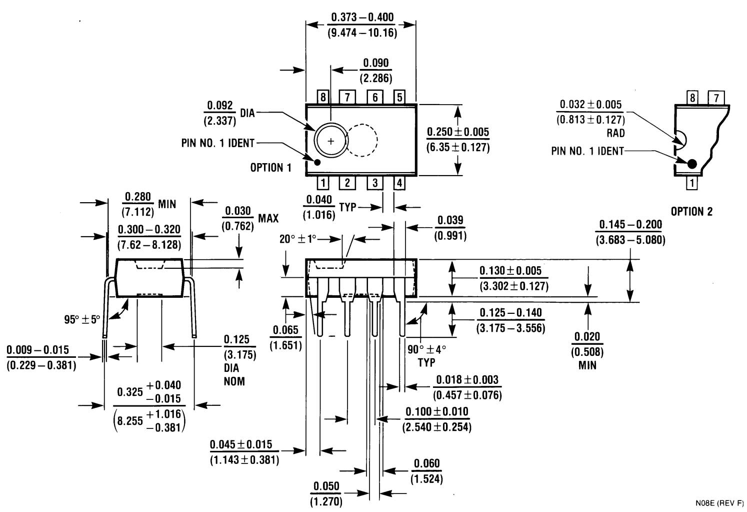
Note 6: At volume of change = ±12 dB
Q = 1.7

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

Physical Dimensions inches (millimeters) unless otherwise noted

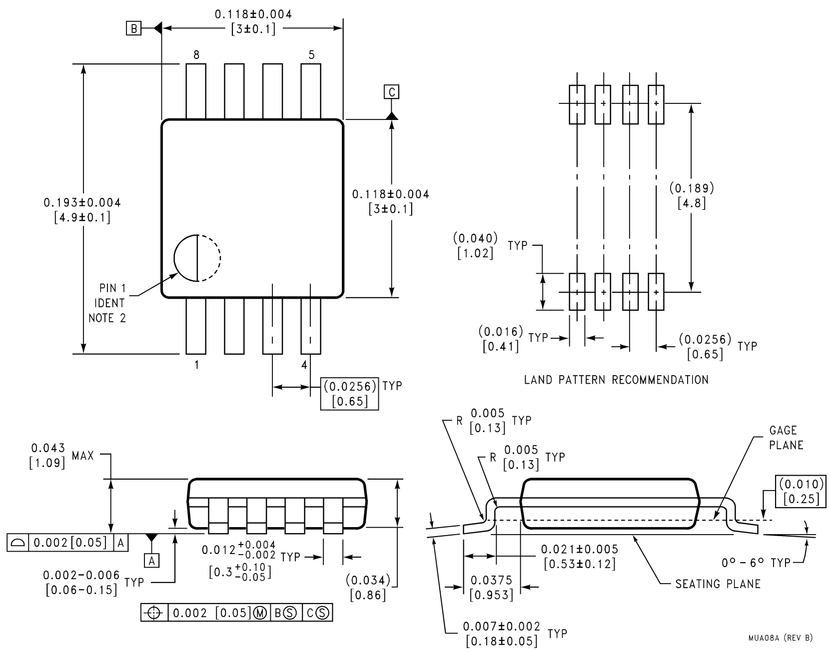


Molded Small Outline Package (M)
Order Number LM833M
NS Package Number M08A



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

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



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

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MOTOROLA

LM833

Dual Low Noise, Audio Amplifier

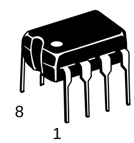
DUAL OPERATIONAL AMPLIFIER

SEMICONDUCTOR TECHNICAL DATA

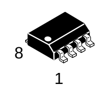
The LM833 is a standard low–cost monolithic dual general–purpose operational amplifier employing Bipolar technology with innovative high–performance concepts for audio systems applications. With high frequency PNP transistors, the LM833 offers low voltage noise (4.5 nV/$\sqrt{Hz}$), 15 MHz gain bandwidth product, 7.0 V/µs slew rate, 0.3 mV input offset voltage with 2.0 µV/°C temperature coefficient of input offset voltage. The LM833 output stage exhibits no deadband crossover distortion, large output voltage swing, excellent phase and gain margins, low open loop high frequency output impedance and symmetrical source/sink AC frequency response.

The LM833 is specified over the automotive temperature range and is available in the plastic DIP and SO–8 packages (P and D suffixes). For an improved performance dual/quad version, see the MC33079 family.

- Low Voltage Noise: 4.5 nV/$\sqrt{Hz}$
- High Gain Bandwidth Product: 15 MHz
- High Slew Rate: 7.0 V/µs
- Low Input Offset Voltage: 0.3 mV
- Low T.C. of Input Offset Voltage: 2.0 µV/°C
- Low Distortion: 0.002%
- Excellent Frequency Stability
- Dual Supply Operation

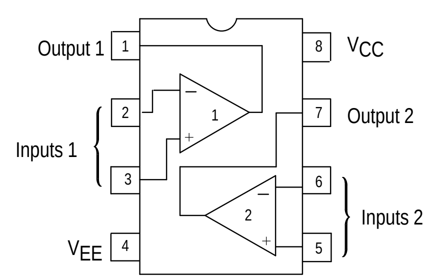


N SUFFIX
PLASTIC PACKAGE
CASE 626



D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO–8)

PIN CONNECTIONS



(Top View)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage (V_{CC} to V_{EE})	V_S	+36	V
Input Differential Voltage Range (Note 1)	V_{IDR}	30	V
Input Voltage Range (Note 1)	V_{IR}	±15	V
Output Short Circuit Duration (Note 2)	t_{SC}	Indefinite	
Operating Ambient Temperature Range	T_A	–40 to +85	°C
Operating Junction Temperature	T_J	+150	°C
Storage Temperature	T_{stg}	–60 to +150	°C
Maximum Power Dissipation (Notes 2 and 3)	P_D	500	mW

NOTES: 1. Either or both input voltages must not exceed the magnitude of V_{CC} or V_{EE}.
2. Power dissipation must be considered to ensure maximum junction temperature (T_J) is not exceeded (see power dissipation performance characteristic).
3. Maximum value at $T_A \leq 85°C$.

ORDERING INFORMATION

Device	Operating Temperature Range	Package
LM833N	T_A = – 40° to +85°C	Plastic DIP
LM833D		SO–8

 Rev 0

ELECTRICAL CHARACTERISTICS (V_{CC} = +15 V, V_{EE} = –15 V, T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Input Offset Voltage (R_S = 10 Ω, V_O = 0 V)	V_{IO}	–	0.3	5.0	mV
Average Temperature Coefficient of Input Offset Voltage R_S = 10 Ω, V_O = 0 V, T_A = T_{low} to T_{high}	$\Delta V_{IO}/\Delta T$	–	2.0	–	µV/°C
Input Offset Current (V_{CM} = 0 V, V_O = 0 V)	I_{IO}	–	10	200	nA
Input Bias Current (V_{CM} = 0 V, V_O = 0 V)	I_{IB}	–	300	1000	nA
Common Mode Input Voltage Range	V_{ICR}	– –12	+14 –14	+12 –	V
Large Signal Voltage Gain (R_L = 2.0 kΩ, V_O = ±10 V	A_{VOL}	90	110	–	dB
Output Voltage Swing: R_L = 2.0 kΩ, V_{ID} = 1.0 V R_L = 2.0 kΩ, V_{ID} = 1.0 V R_L = 10 kΩ, V_{ID} = 1.0 V R_L = 10 kΩ, V_{ID} = 1.0 V	 V_{O+} V_{O-} V_{O+} V_{O-}	 10 – 12 –	 13.7 –14.1 13.9 –14.7	 – –10 – –12	V
Common Mode Rejection (V_{in} = ±12 V)	CMR	80	100	–	dB
Power Supply Rejection (V_S = 15 V to 5.0 V, –15 V to –5.0 V)	PSR	80	115	–	dB
Power Supply Current (V_O = 0 V, Both Amplifiers)	I_D	–	4.0	8.0	mA

AC ELECTRICAL CHARACTERISTICS (V_{CC} = +15 V, V_{EE} = –15 V, T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Slew Rate (V_{in} = –10 V to +10 V, R_L = 2.0 kΩ, A_V = +1.0)	S_R	5.0	7.0	–	V/µs
Gain Bandwidth Product (f = 100 kHz)	GBW	10	15	–	MHz
Unity Gain Frequency (Open Loop)	f_U	–	9.0	–	MHz
Unity Gain Phase Margin (Open Loop)	θ_m	–	60	–	Deg
Equivalent Input Noise Voltage (R_S = 100 Ω, f = 1.0 kHz)	e_n	–	4.5	–	$nV/\sqrt{Hz}$
Equivalent Input Noise Current (f = 1.0 kHz)	i_n	–	0.5	–	$pA/\sqrt{Hz}$
Power Bandwidth (V_O = 27 V_{pp}, R_L = 2.0 kΩ, THD ≤ 1.0%)	BWP	–	120	–	kHz
Distortion (R_L = 2.0 kΩ, f = 20 Hz to 20 kHz, V_O = 3.0 V_{rms}, A_V = +1.0)	THD	–	0.002	–	%
Channel Separation (f = 20 Hz to 20 kHz)	C_S	–	–120	–	dB

Figure 1. Maximum Power Dissipation versus Temperature

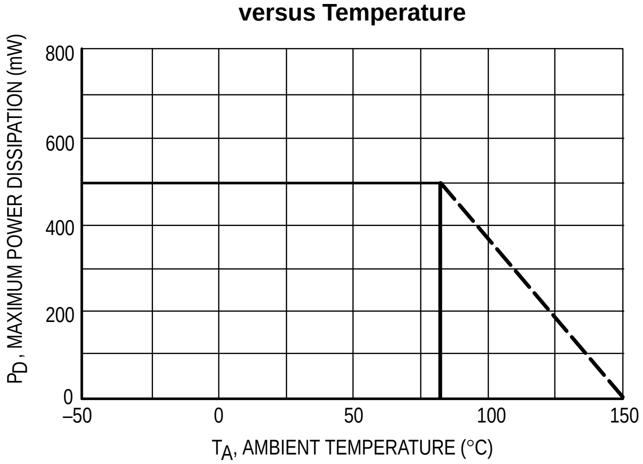


Figure 2. Input Bias Current versus Temperature

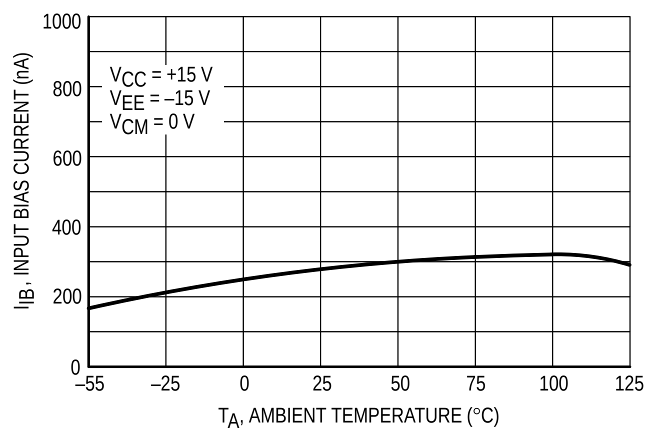


Figure 3. Input Bias Current versus Supply Voltage

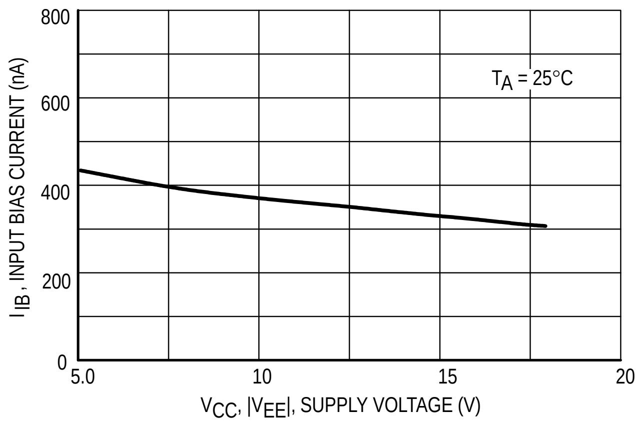


Figure 4. Supply Current versus Supply Voltage

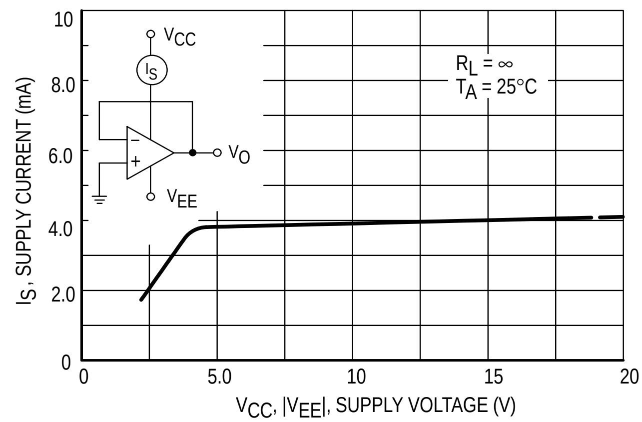


Figure 5. DC Voltage Gain versus Temperature

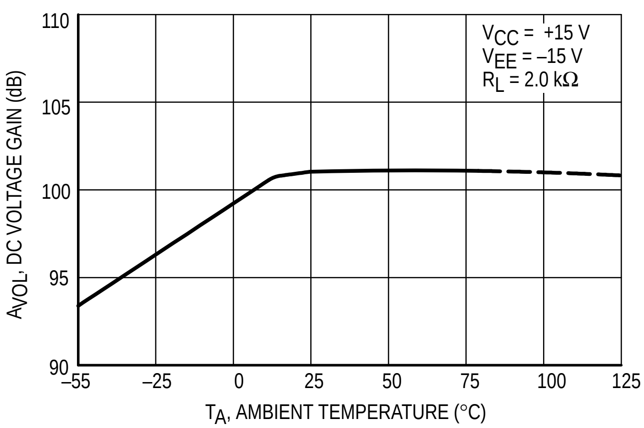


Figure 6. DC Voltage Gain versus Supply Voltage

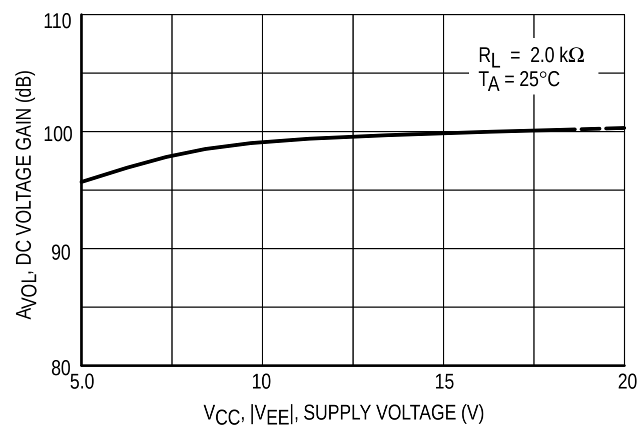


Figure 7. Open Loop Voltage Gain and Phase versus Frequency

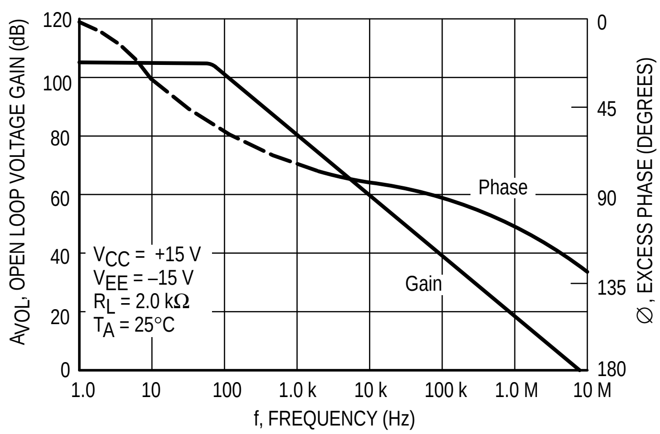


Figure 8. Gain Bandwidth Product versus Temperature

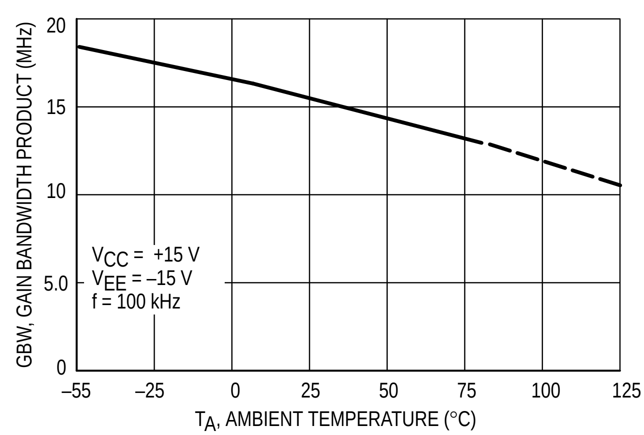


Figure 9. Gain Bandwidth Product versus Supply Voltage

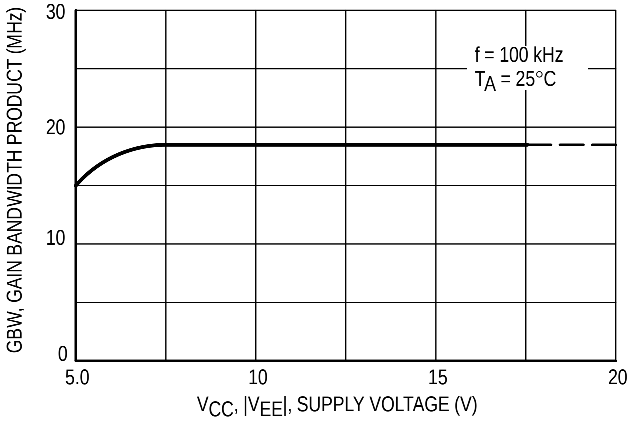


Figure 10. Slew Rate versus Temperature

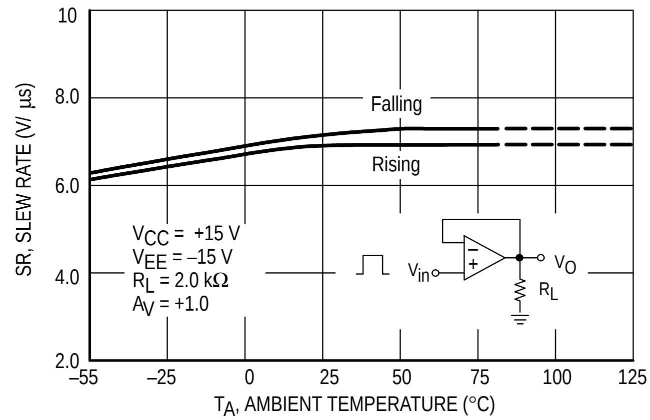


Figure 11. Slew Rate versus Supply Voltage

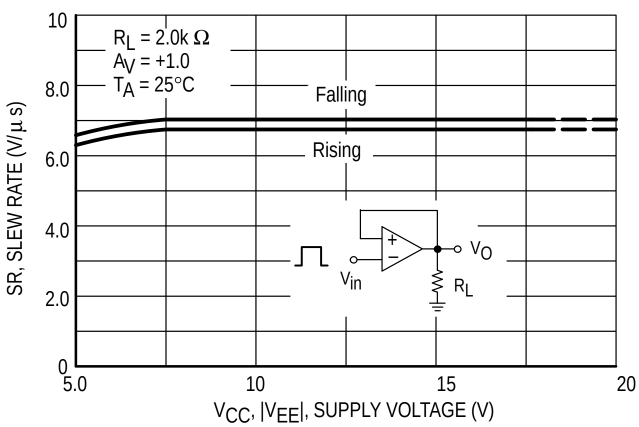


Figure 12. Output Voltage versus Frequency

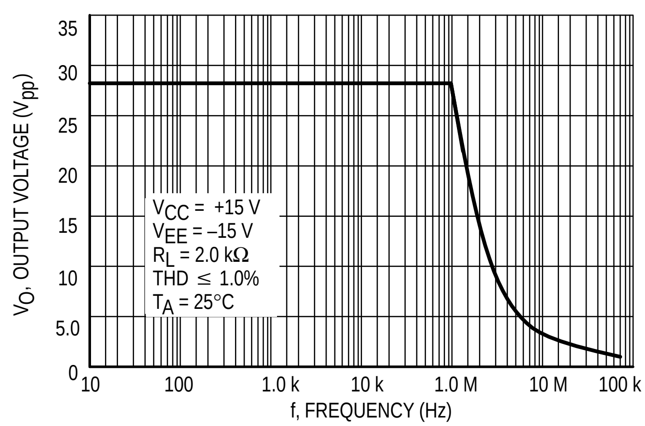


Figure 13. Maximum Output Voltage versus Supply Voltage

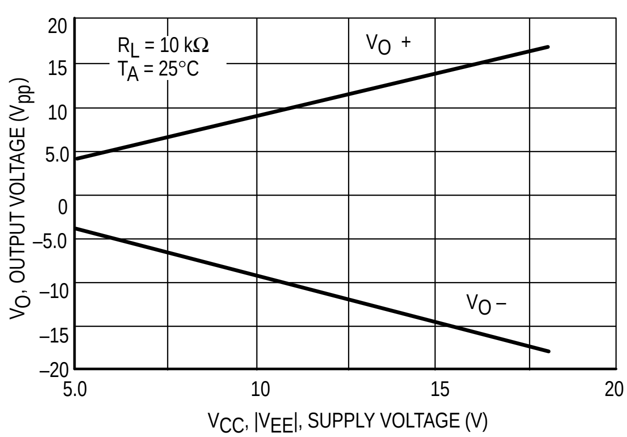


Figure 14. Output Saturation Voltage versus Temperature

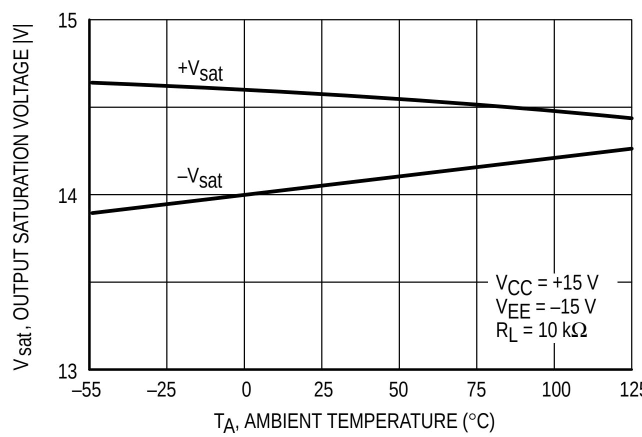


Figure 15. Power Supply Rejection versus Frequency

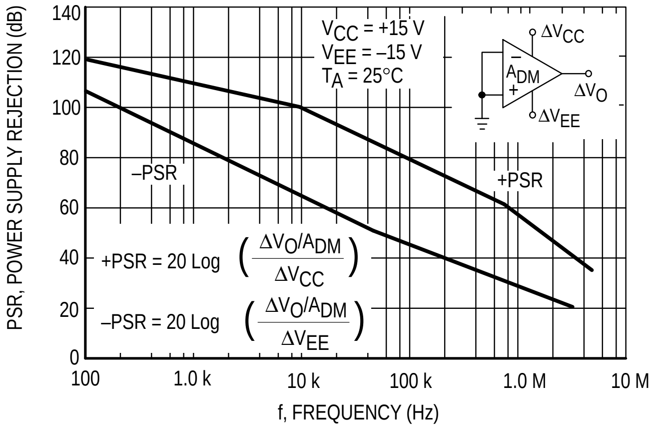


Figure 16. Common Mode Rejection versus Frequency

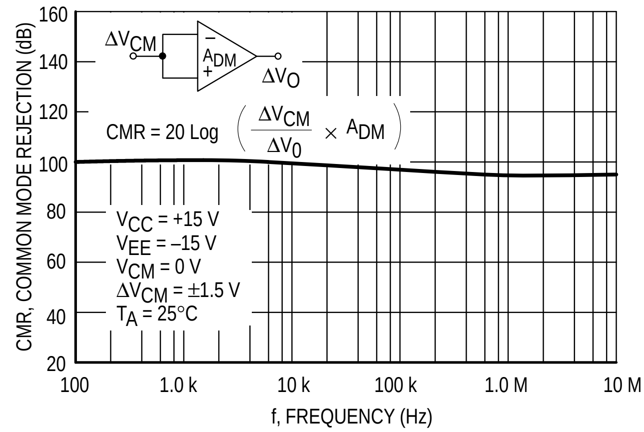


Figure 17. Total Harmonic Distortion versus Frequency

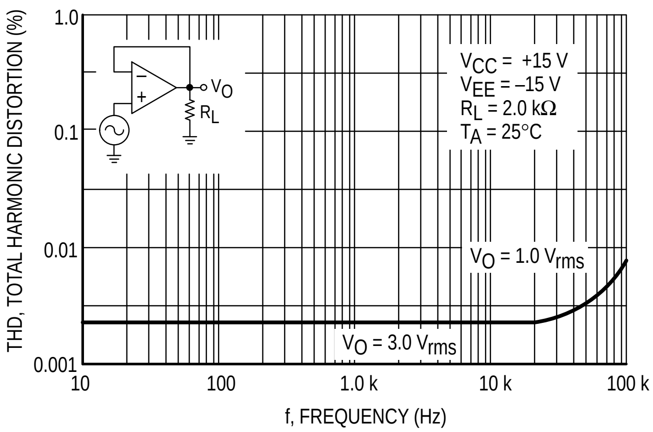


Figure 18. Input Referred Noise Voltage versus Frequency

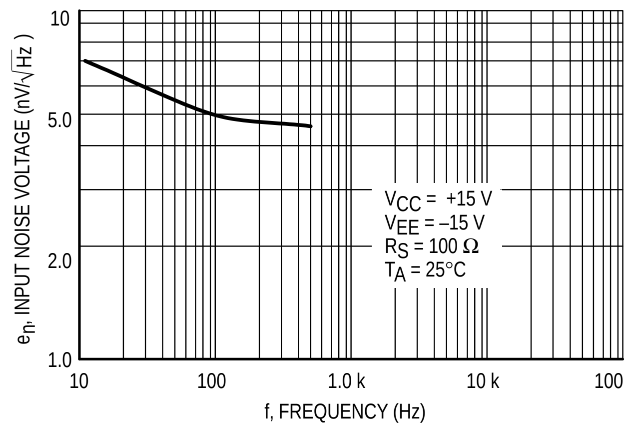


Figure 19. Input Referred Noise Current versus Frequency

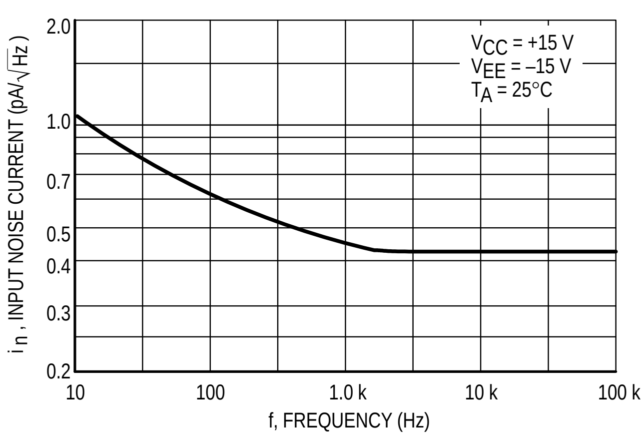


Figure 20. Input Referred Noise Voltage versus Source Resistance

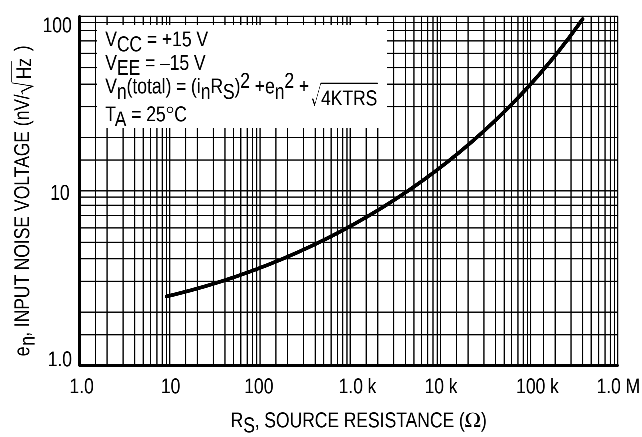


Figure 21. Inverting Amplifier

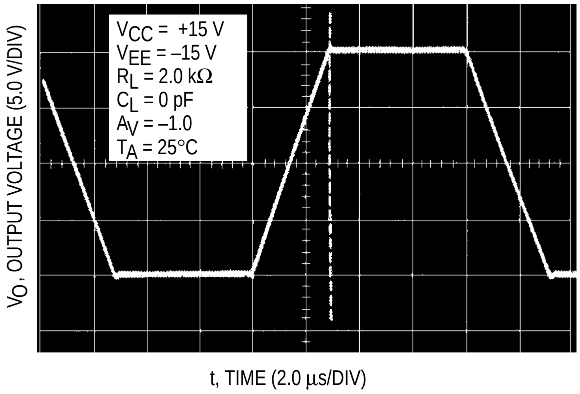


Figure 22. Noninverting Amplifier Slew Rate

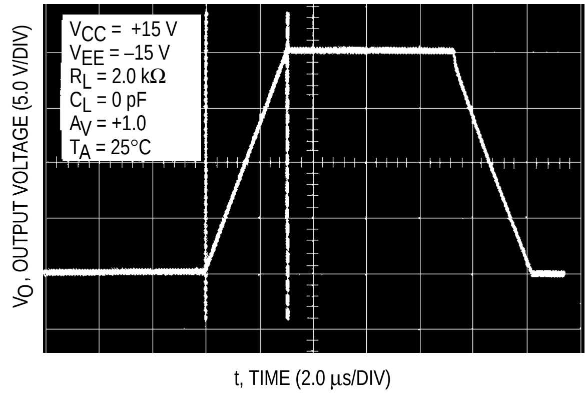
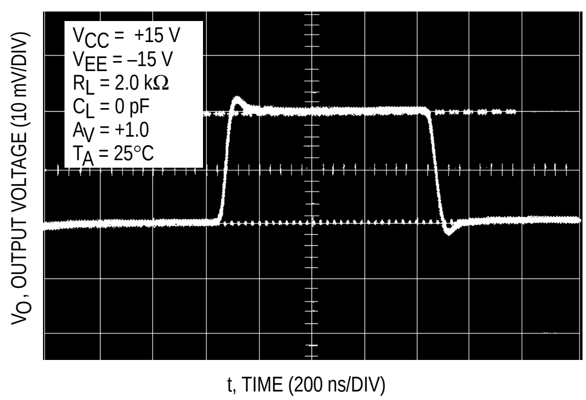
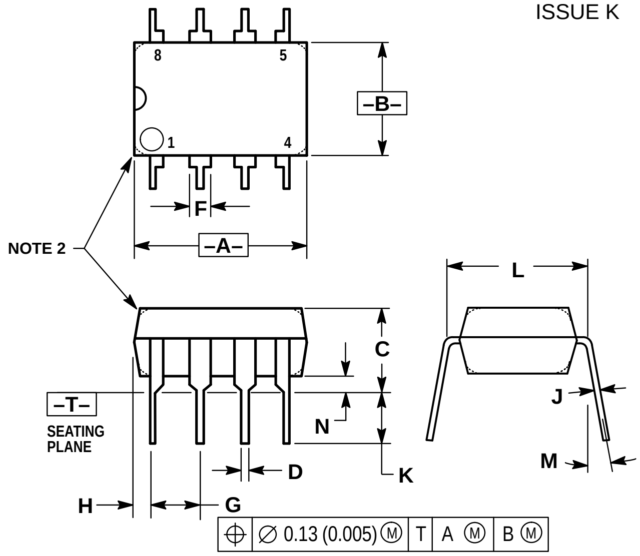


Figure 23. Noninverting Amplifier Overshoot



OUTLINE DIMENSIONS

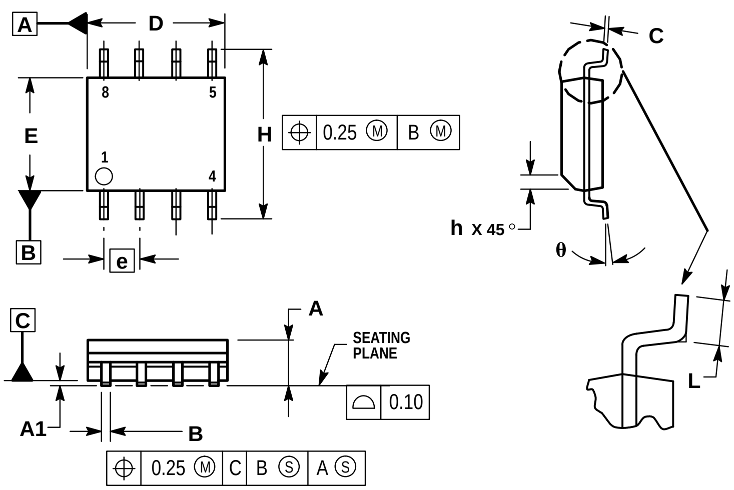
N SUFFIX
PLASTIC PACKAGE
CASE 626–05
ISSUE K



NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	—	10°	—	10°
N	0.76	1.01	0.030	0.040

D SUFFIX
PLASTIC PACKAGE
CASE 751–05
(SO–8)
ISSUE R



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS	
DIM	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.35	0.49
C	0.18	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.25
θ	0°	7°

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MFAX: RMFAX0@email.sps.mot.com – TOUCHTONE 602–244–6609
INTERNET: http://Design–NET.com

JAPAN: Nippon Motorola Ltd.; Tatsumi–SPD–JLDC, 6F Seibu–Butsuryu–Center, 3–14–2 Tatsumi Koto–Ku, Tokyo 135, Japan. 03–81–3521–8315

ASIA / PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park, 51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852–26629298

LM833/A 2回路, 低雑音

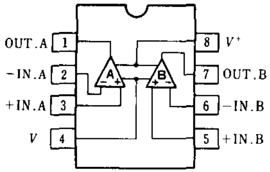
National Semiconductor

●入力雑音電圧:4.5nV/√Hz
●スルーレート:7V/μs
●THD:0.002%

セカンド・ソース			類似品
MOT:LM833 富士通:MB47833 松下:AN1833			JRC:NJM2041 NEC:μPC4570

■ピン接続図

(TOP VIEW)



LM833N

●電気的特性	●最大定格	LM833A	LM833	単位
Vs=±15V	電源電圧	±18	±18	V
Ta=25℃	入力電圧	±15	±15	V
	差動入力電圧	±30	±30	V
	動作温度	-40～+85	-40～+85	℃
	許容損失	/	/	mW

規格	記号	条件	LM833A 標準値	LM833A 最悪値	LM833 標準値	LM833 最悪値	単位
入力オフセット電圧	Vos		0.3	5	0.3	5	mV
Voの温度ドリフト	TC/Vos		2	/	2	/	μV/℃
Voの長期安定性	Vos/time		/	/	/	/	μV/月
入力バイアス電流	Ib		500	1000	500	1000	nA
入力オフセット電流	Ios		10	200	10	200	nA
入力雑音電圧	Vn	①	0.5	0.8	/	/	μVp-p
入力雑音電圧密度	en		/	/	/	/	nV/√Hz
入力雑音電流密度	in		/	/	/	/	pA/√Hz
差動入力抵抗	Rin		/	/	/	/	MΩ
同相入力抵抗	RinCM		/	/	/	/	GΩ
同相入力電圧範囲	VCM		±14	±12	±14	±12	V
同相信号除去比	CMRR	②	100	80	100	80	dB
電源変動除去比	PSRR	③	100	80	100	80	dB
大信号電圧利得	Avo	④	110	90	110	90	V/mV
出力電圧振幅	Vo	⑤	±13.5	±12	±13.5	±12	V
出力インピーダンス	Zo		/	/	/	/	Ω
出力電流	Io		/	/	/	/	mA
電源電流	Is		5	8	5	8	mA
スルーレート	SR	⑥	7	5	7	5	V/μs
利得帯域幅積	GBW	⑦	15	10	15	10	MHz
帯域幅	fT		/	/	/	/	MHz
ライズ・タイム	tr		/	/	/	/	ns
セトリング・タイム	ts		/	/	/	/	ns
オーバシュート	OS		/	/	/	/	%
微分利得	DG		/	/	/	/	%
群遅延特性	GD		/	/	/	/	degree
高調波ひずみ率	THD	⑧	0.002	/	0.002	/	%
チャネル・セパレーション	CS		120	/	120	/	dB

条件		
	① RIAA, Rs=470	⑥ RL=2k
	② VCM=±12V	⑦ f=100kHz
	③ Vs=±5～±15V	⑧ RL=2k, f=20～20kHz, Vo=3Vrms
	④ RL=2k, Vo=±10V	
	⑤ RL=10k	

Amplifiers and Comparators

In Brief . . .

For over two decades, Motorola has continually refined and updated integrated circuit technologies, analog circuit design techniques and processes in response to the needs of the marketplace. The enhanced performance of newer operational amplifiers and comparators has come through innovative application of these technologies, designs and processes. Some early designs are still available but are giving way to the new, higher performance operational amplifier and comparator circuits. Motorola has pioneered in JFET inputs, low temperature coefficient input stages, Miller loop compensation, all NPN output stages, dual–doublet frequency compensation and analog "in–the–package" trimming of resistors to produce superior high performance operational amplifiers and comparators, operating in many cases from a single supply with low input offset, low noise, low power, high output swing, high slew rate and high gain–bandwidth product at reasonable cost to the customer.

Present day operational amplifiers and comparators find applications in all market segments including motor controls, instrumentation, aerospace, automotive, telecommunications, medical, and consumer products.

Page

Operational Amplifiers

Motorola offers a broad line of bipolar operational amplifiers to meet a wide range of applications. From low–cost industry–standard types to high precision circuits, the span encompasses a large range of performance capabilities. These Analog integrated circuits are available as single, dual and quad monolithic devices in a variety of temperature ranges and package styles. Most devices may be obtained in unencapsulated "chip" form as well. For price and delivery information on chips, please contact your Motorola Sales Representative or Distributor.

Table 1. Single Operational Amplifiers

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
Noncompensated											
Commercial Temperature Range (0°C to +70°C)											
LM301A	0.25	7.5	10	50	25	1.0	0.5	±3.0	±18	General Purpose	N/626, D/751
LM308A	7.0	0.5	5.0	1.0	80	1.0	0.3	±3.0	±18	Precision	N/626, D/751
Industrial Temperature Range (–25°C to +85°C)											
LM201A	0.075	2.0	10	10	50	1.0	0.5	±3.0	±22	General Purpose	N/626, D/751
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF351	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	N/626, D/751
LF411C	200 pA	2.0	10	100 pA	25	8.0	25	+5.0	±22	JFET Input, Low Offset, Low Drift	N/626, D/751
MC1436, C	0.04	10	12	10	70	1.0	2.0	±15	±34	High Voltage	P1/626, D/751
MC1741C	0.5	6.0	15	200	20	1.0	0.5	±3.0	±18	General Purpose	P1/626, D/751
MC1776C	0.003	6.0	15	3.0	100	1.0	0.2	±1.2	±18	µPower, Programmable	P1/626, D/751
MC3476	0.05	6.0	15	25	50	1.0	0.2	±1.5	±18	Low Cost, µPower, Programmable	P1/626
MC34001	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	P/626, D/751
MC34001B	200 pA	5.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	P/626, D/751
MC34071	0.5	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	P/626, D/751
MC34071A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	P/626, D/751
MC34080B	200 pA	1.0	10	100 pA	25	16	55	±5.0	±22	Decompensated	P/626, D/751
MC34081B	200 pA	1.0	10	100 pA	25	8.0	30	±5.0	±22	High Speed, JFET Input	P/626, D/751
MC34181	0.1 nA	2.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	P/626
TL071AC	200 pA	6.0	10	50 pA	50	4.0	13	±5.0	±18	Low Noise, JFET Input	P/626
TL071C	200 pA	10	10	50 pA	25	4.0	13	±5.0	±18	Low Noise, JFET Input	D/751
TL081AC	200 pA	6.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	P/626
TL081C	400 pA	15	10	200 pA	25	4.0	13	±5.0	±18	JFET Input	D/751
Automotive Temperature Range (–40°C to +85°C)											
MC33071	0.5	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	P/626, D/751
MC33071A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	P/626, D/751
MC33171	0.1	4.5	10	20	50	1.8	2.1	+3.0	+44	Low Power, Single Supply	P/626, D/751
MC33181	0.1 nA	2.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	P/626, D/751
Extended Temperature Range (–40°C to +105°C)											
MC33201	250 nA	9.0	2.0	100	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/626, D/751
Military Temperature Range (–55°C to +125°C)											
MC33201	400 nA	9.0	2.0	200	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/626, D/751

Table 2. Dual Operational Amplifiers

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF353	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	N/626, D/751
LF412C	200 pA	3.0	10	100 pA	25	4.0	13	+5.0	±18	JFET Input, Low Offset, Low Drift	N/626, D/751
LF442C	100 pA	5.0	10	50 pA	25	2.0	6.0	±5.0	±18	Low Power, JFET Input	N/626
LM358	0.25	6.0	7.0	50	25	1.0	0.6	±1.5 +3.0	±18 +36	Single Supply, Low Power Consumption	N/626, D/751
LM833	1.0	5.0	2.0	200	31.6	15	7.0	+2.5	±18	Low Noise, Audio	N/626, D/751
MC1458	0.5	6.0	10	200	20	1.1	0.8	±3.0	±18	Dual MC1741	P1/626, D/751
MC1458C	0.7	10	10	300	20	1.1	0.8	±3.0	±18	General Purpose	P1/626, D/751
MC3458	0.5	10	7.0	50	20	1.0	0.6	±1.5 +3.0	±18 +36	Split Supplies, Single Supply, Low Crossover Distortion	P1/626, D/751
MC4558AC	0.5	5.0	10	200	50	2.8	1.6	±3.0	±22	High Frequency	P1/626
MC4558C	0.5	6.0	10	200	20	2.8	1.6	±3.0	±18	High Frequency	P1/626, D/751
MC34002	100 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	P/626, D/751
MC34002B	100 pA	5.0	10	70 pA	25	4.0	13	±5.0	±18	JFET Input	P/626, D/751
MC34072	0.5	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	P/626, D/751
MC34072A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	P/626, D/751
MC34082	200 pA	3.0	10	100 pA	25	8.0	30	±5.0	±22	High Speed, JFET Input	P/626
MC34083B	200 pA	3.0	10	100 pA	25	16	55	±5.0	±22	Decompensated	P/626
MC34182	0.1 nA	3.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	P/626, D/751
TL062AC	200 pA	6.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	P/626, D/751
TL062C	200 pA	15	10	200 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	P/626, D/751
TL072AC	200 pA	6.0	10	50 pA	50	4.0	13	±5.0	±18	Low Noise, JFET Input	P/626
TL072C	200 pA	10	10	50 pA	25	4.0	13	±5.0	±18	Low Noise, JFET Input	D/751
TL082AC	200 pA	6.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	P/626
TL082C	400 pA	15	10	200 pA	25	4.0	13	±5.0	±18	JFET Input	D/751
Industrial Temperature Range (–25°C to +85°C)											
LM258	0.15	5.0	10	30	50	1.0	0.6	±1.5 +3.0	±18 +36	Split or Single Supply Op Amp	N/626, D/751
Automotive Temperature Range (–40°C to +85°C)											
MC3358	5.0	8.0	10	75	20	1.0	0.6	±1.5 +3.0	±18 +36	Split or Single Supply	P1/626
MC33072	0.50	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	P/626, D/751
MC33072A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	P/626, D/751
MC33076	0.5	4.0	2.0	70	25	7.4	2.6	±2.0	±18	High Output Current	P1/626, P2/648C, D/751
MC33077	1.0	1.0	2.0	180	150	37	11	±2.5	±18	Low Noise	P/626, D/751
MC33078	750 nA	2.0	2.0	150	31.6	16	7.0	±5.0	±18	Low Noise	N/626, D/751
MC33102											P/626, D/751
(Awake)	600 nA	3.0	1.0	60	25	4.6	1.7	±2.5	±18	Sleep–Mode™	
(Sleep)	60 nA	3.0	1.0	6.0	15	0.3	0.1	±2.5	±18	Micropower	
MC33172	0.10	4.5	10	20	50	1.8	2.1	+3.0	+44	Low Power, Single Supply	P/626, D/751
MC33178	0.5	3.0	2.0	50	50	5.0	2.0	±2.0	±18	High Output Current	P/626, D/751
MC33182	0.1 nA	3.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	P/626, D/751
MC33272A	650 nA	1.0	0.56	25 nA	31.6	5.5	11.5	±1.5	±18	High Performance	P/626, D/751
MC33282	100 pA	200 µV	5.0	50 pA	50	30	12	±2.5	±18	Low Input, Offset JFET	P/626, D/751
TL062V	200 pA	6.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	P/626, D/751

Table 2. Dual Operational Amplifiers (continued)

Device	I_{IB} (μA) Max	V_{IO} (mV) Max	TC_{VIO} (μV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/μs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
Extended Temperature Range (–40°C to +105°C)											
MC33202	250 nA	11	2.0	100	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/626, D/751
MC33206										Rail–to–Rail with Enable	P/646, D/751A
MC33502	40 fA typ	0.5 typ	2.0 typ	–	100 typ	4.0 typ	4.0 typ	+0.9	+7.0	1.0 V Rail–to–Rail	P/262, D751
LM2904	0.25	10	7.0	50	100 typ	1.0	0.6	±1.5 +3.0	±13 +26	Split or Single Supply	N/262, D/751
Extended Automotive Temperature Range (–40°C to +125°C)											
TCA0372	500 nA	15	20	50	30	1.1	1.4	+5.0	+36	Power Op Amp, Single Supply	DP2/648, DW/751G
LM2904V	0.25	13	7.0	50	100 typ	1.0	0.6	±1.5 +3.0	±13 +26	Split or Single Supply	N/626, D/751
Military Temperature Range (–55°C to +125°C)											
MC33202	400 pA	11	2.0	200 pA	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/626, D/751

Table 3. Quad Operational Amplifiers

Device	I_{IB} (μA) Max	V_{IO} (mV) Max	TC_{VIO} (μV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/μs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF347	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	N/646
LF347B	200 pA	5.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	N/646
LF444C	100 pA	10	10	50 pA	25	2.0	6.0	±5.0	±18	Low Power, JFET Input	N/646, D/751A
LM324, A	0.25	6.0	7.0	50	25	1.0	0.6	±1.5 +3.0	±16 +32	Low Power Consumption	N/646, D/751A
MC3403	0.5	10	7.0	50	20	1.0	0.6	±1.5 +3.0	±18 +36	No Crossover Distortion	P/646, D/751A
MC4741C	0.5	6.0	15	200	20	1.0	0.5	±3.0	±18	Quad MC1741	P/646, D/751A
MC34004	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	P/646
MC34004B	200 pA	5.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	P/646
MC34074	0.5	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	P/646, D/751A
MC34074A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	P/646, D/751A
MC34084	200 pA	12	10	100 pA	25	8.0	30	±5.0	±22	High Speed, JFET Input	P/646, DW/751G
MC34085B	200 pA	12	10	100 pA	25	16	55	±5.0	±22	Decompensated	P/646, DW/751G
MC34184	0.1 nA	10	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	P/646, D/751A
TL064AC	200 pA	6.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	N/646, D/751A
TL064C	200 pA	15	10	200 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	N/646, D/751A
TL074AC	200 pA	6.0	10	50 pA	50	4.0	13	±5.0	±18	Low Noise, JFET Input	N/646
TL074C	200 pA	10	10	50 pA	25	4.0	13	±5.0	±18	Low Noise, JFET Input	N/646
TL084AC	200 pA	6.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	N/646
TL084C	400 pA	15	10	200 pA	25	4.0	13	±5.0	±18	JFET Input	N/646
Industrial Temperature Range (–25°C to +85°C)											
LM224, A	0.15	5.0	7.0	30	50	1.0	0.6	±1.5 +3.0	±16 +32	Split Supplies or Single Supply	N/646, D/751A

Table 3. Quad Operational Amplifiers (continued)

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
Automotive Temperature Range (–40°C to +85°C)											
MC3303	0.5	8.0	10	75	20	1.0	0.6	±1.5 +3.0	±18 +36	Differential General Purpose	P/646, D/751A
MC33074	0.5	4.5	10	75	25	4.5	10	+3.0	+44	High Performance, Single Supply	P/646, D/751A
MC33074A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	High Performance	P/646, D/751A
MC33079	750 nA	2.5	2.0	150	31.6	9.0	7.0	±5.0	±18	Low Noise	N/646, D/751A
MC33174	0.1	4.5	10	20	50	1.8	2.1	+3.0	+44	Low Power, Single Supply	P/646, D/751A
MC33179	0.5	3.0	2.0	50	50	5.0	2.0	±2.0	±18	High Output Current	P/646, D/751A
MC33184	0.1 nA	10	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	P/646, D/751A
MC33274A	650 nA	1.0	0.56	25 nA	31.6	5.5	11.5	±1.5	±18	High Performance	P/646, D/751A
MC33284	100 pA	2.0	5.0	50 pA	50	30	12	±2.5	±18	Low Input, Offset JFET	P/646, D/751A
TL064V	200 pA	9.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	N/646, D/751A
Extended Temperature Range (–40°C to +105°C)											
MC33204	250 nA	13	2.0	100	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/646, D/751A
MC33207					50	2.2		±0.9	±6.0	Rail–to–Rail with Enable	P/648, D/751B
MC33304					25	3.0		+1.8	+12	Sleepmode, Rail–to–Rail	P/646, D/751A
LM2902	0.5	10	–	50	15	1.0	0.6	±1.5 +3.0	±13 +26	Differential Low Power	N/646, D/751A
Extended Automotive Temperature Range (–40°C to +125°C)											
LM2902V	0.5	13	–	50	15	1.0	0.6	±1.5 +3.0	±13 +26	Differential Low Power	N/646, D/751A
Military Temperature Range (–55°C to +125°C)											
MC33204	400 pA	13	2.0	200 pA	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/646, D/751A

One Volt SMARTMOS™ Rail–to–Rail Dual Operational Amplifier

MC33502D, P

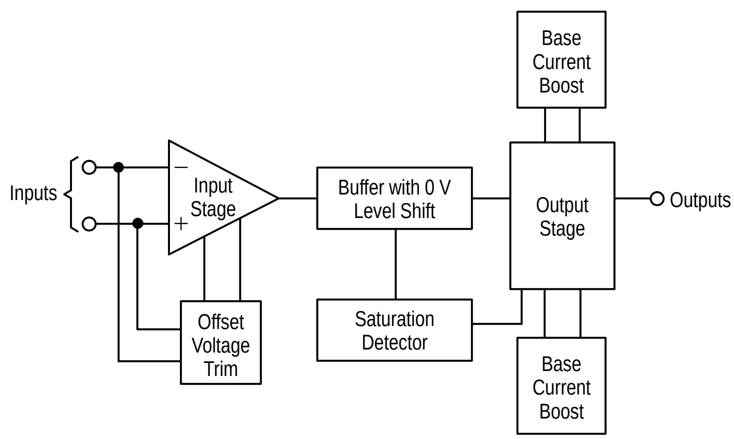
T_A = –40° to +105°C, Case 751, 626

The MC33502 operational amplifier provides rail–to–rail operation on both the input and output. The output can swing within 50 mV of each rail. This rail–to–rail operation enables the user to make full use of the entire supply voltage range available. It is designed to work at very low supply voltages (1.0 V and ground), yet can operate with a supply of up to 7.0 V and ground. Output current boosting techniques provide high output current capability while keeping the drain current of the amplifier to a minimum.

- Low Voltage, Single Supply Operation (1.0 V and Ground to 7.0 V and Ground)
- High Input Impedance: Less than 40 fA Input Current
- Typical Unity Gain Bandwidth @ 5.0 V = 5.0 MHz, @ 1.0 V = 4.0 MHz
- High Output Current (I_{SC} = 50 mA @ 5.0 V, 10 mA @ 1.0 V)
- Output Voltage Swings within 50 mV of Both Rails
- Input Voltage Range Includes Both Supply Rails
- High Voltage Gain: 100 dB
- No Phase Reversal on the Output for Over–Driven Input Signals
- Input Offset Trimmed to <500 µV Typical
- Low Supply Current (I_D = 1.2 mA, Typical)
- 600 Ω Drive Capability
- Extended Operating Temperature Range (–40° to 105°C)

APPLICATIONS

- Single Cell NiCd/Ni MH Powered Systems
- Single Cell Lithium Powered Systems
- Portable Communication Devices
- Low Voltage Active Filters
- General Systems Requiring Battery Power



High Frequency Amplifiers

A variety of high frequency circuits with features ranging from low cost simplicity to multifunction versatility marks Motorola's line of integrated amplifiers. Devices described here are intended for industrial and communications applications. For devices especially dedicated to consumer products, i.e., TV and entertainment radio. (See the Consumer Electronics Circuits section.)

AGC Amplifiers

MC1490/MC1350 Family Wideband General Purpose Amplifiers

The MC1490 and MC1350 family are basic building blocks – AGC (Automatic Gain Controlled) RF/Video Amplifiers. These parts are recommended for applications up through 70 MHz. The best high frequency performance may be obtained by using the physically smaller SOIC version (shorter leads) – MC1350D. There are currently no other RF ICs like these, because other manufacturers have dropped their copies. Applications include variable gain video and instrumentation amplifiers, IF (Intermediate Frequency) amplifiers for radio and TV receivers, and transmitter power output control. Many uses will be found in medical instrumentation, remote monitoring, video/graphics processing, and a variety of communications equipment. The family of parts using the same basic die (identical circuit with slightly different test parameters) is listed in the following table.

Table 4. High Frequency Amplifier Specifications

Operating Temperature Range		A_V (dB)	Bandwidth @ MHz	V_{CC}/V_{EE} (Vdc)		Suffix/ Package
−40° to +85°C	0° to +70°C	Typical		Minimum	Maximum	
–	MC1350	50	45	+6.0	+18	P/626, D/751
MC1490	–	50 45 35	10 60 100			P/626

Miscellaneous Amplifiers

Motorola provides several Bipolar and CMOS special purpose amplifiers which fill specific needs. These devices range from low power CMOS programmable amplifiers and comparators to variable–gain bipolar power amplifiers.

MC3405
Dual Operational Amplifier and Dual Voltage Comparator

This device contains two Differential Input Operational Amplifiers and two Comparators; each set capable of single supply operation. This operational amplifier–comparator circuit will find its applications as a general purpose product for automotive circuits and as an industrial ‘‘building block.’’

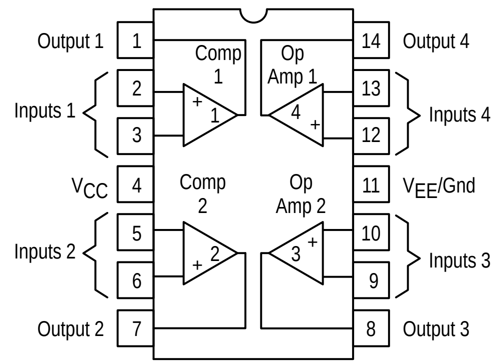


Table 5. Bipolar

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (nA) Max	A_{vol} (V/mV) Min	Response (µs) Typ	Supply Voltage Single	Supply Voltage Dual	Suffix/ Package
MC3405	0.5	10	50	20	1.3	3.0 to 36	±1.5 to ±18	P/646

MC14573
Quad Programmable Operational Amplifier
MC14575
Dual Programmable Operational Amplifier and Dual Programmable Comparator
MC14576C/MC14577C
Dual Video Amplifiers

Table 6. CMOS

Function	Quantity Per Package	Single Supply Voltage Range	Dual Supply Voltage Range	Frequency Range	Device	Suffix/ Package
Operational Amplifiers	4	3.0 to 15 V	±1.5 to ±7.5 V	DC to 1.0 MHz	MC14573	P/648, D/751B
Operational Amplifiers and Comparators	2 and 2	3.0 to 15 V	±1.5 to ±7.5 V	DC to 1.0 MHz	MC14575	P/648, D/751B
Video Amplifiers	2	5.0 to 12 V(1)	±2.5 to ±6.0 V(2)	Up to 10 MHz	MC14576C MC14577C	P/626, F/904

(1) 5.0 to 10 V for surface mount package.
(2) ±2.5 to ±5.0 V for surface mount package.

Comparators

Table 7. Single Comparators

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (µA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
Bipolar										
LM211 LM311	0.1 0.25	3.0 7.5	0.01 0.05	200 k	8.0	200	+15, –15	With strobe, will operate from single supply	–25 to +85 0 to +70	D/751 N/626, D/751
CMOS										
MC14578	1.0 pA	50	–	–	1.1	–	3.5 to 14	Requires only 10 µA from single–ended supply	–30 to +70	P/648, D/751B

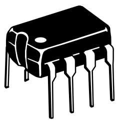
Table 8. Dual Comparators

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (µA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
Bipolar										
LM393 LM393A LM2903 LM2903V	0.25	5.0 2.0 7.0 7.0	0.05	200 k	6.0	1300 1300 1500 1500	±1.5 to ±18 or 3.0 to 36	Designed for single or split supply operation, input common mode includes ground (negative supply)	0 to +70 0 to +70 –40 to +105 –40 to +125	N/626, D/751
MC3405	0.5	10	0.05	200 k	6.0	1300	±1.5 to ±7.5 or 3.0 to 15	This device contains 2 op amps and 2 comparators in a single package	0 to +70	P/646
CMOS										
MC14575	0.001	30	0.0001	2.0 k	3.0	1000	±1.5 to ±7.5 or 3.0 to 15	This device contains 2 op amps and 2 comparators in a single package	–40 to +85	P/648, D/751B

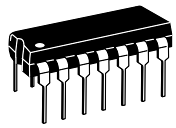
Table 9. Quad Comparators

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (µA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
Bipolar										
LM239 LM239A LM339 LM339A LM2901 LM2901V MC3302	0.25 0.5	5.0 2.0 5.0 2.0 7.0 7.0 20	0.05 0.5	200 k 200 k 200 k 200 k 100 k 100 k 100 k	6.0	1300	±1.5 to ±18 or 3.0 to 36	Designed for single or split supply operation, input common mode includes ground (negative supply)	–25 to +85 –25 to +85 0 to +70 0 to +70 –40 to +85 –40 to +125 –40 to +85	N/646, D/751A P/646
CMOS										
MC14574	0.001	30	0.0001	2.0 k	3.0	1000	±1.5 to ±7.5 or 3.0 to 15	Externally programmable power dissipation with 1 or 2 resistors	–40 to +85	P/648, D/751B

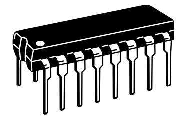
Amplifiers and Comparators Package Overview



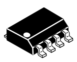
CASE 626
N, P, P1 SUFFIX



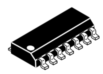
CASE 646
N, P SUFFIX



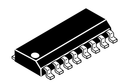
CASE 648, 648C
DP2, P, P2 SUFFIX



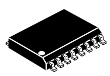
CASE 751
D SUFFIX



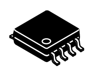
CASE 751A
D SUFFIX



CASE 751B
D SUFFIX



CASE 751G
DW SUFFIX

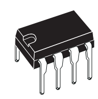


CASE 904
F SUFFIX

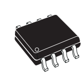
LM833

LOW NOISE DUAL OPERATIONAL AMPLIFIER

- LOW VOLTAGE NOISE: **4.5nV/√Hz**
- HIGH GAIN BANDWIDTH PRODUCT: **15MHz**
- HIGH SLEW RATE: **7V/µs**
- LOW DISTORTION: 0.002%
- EXCELLENT FREQUENCY STABILITY
- ESD PROTECTION 2kV



N
DIP8
(Plastic Package)



D
SO8
(Plastic Micropackage)

DESCRIPTION

The LM833 is a monolithic dual operational amplifier particularly well suited for audio applications. It offers low voltage noise (4.5nV/√Hz) and high frequency performances (15MHz Gain Bandwidth product, 7V/µs slew rate).

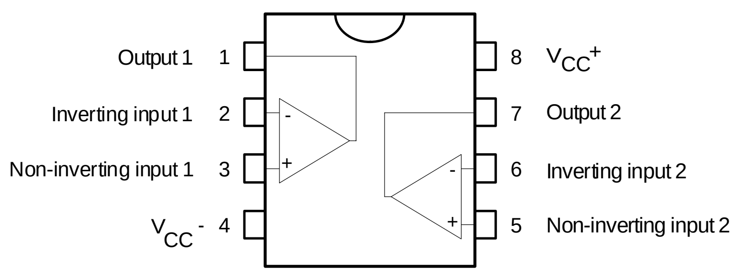
In addition the LM833 has also a very low distortion (0.002%) and excellent phase/gain margins.

ORDER CODE

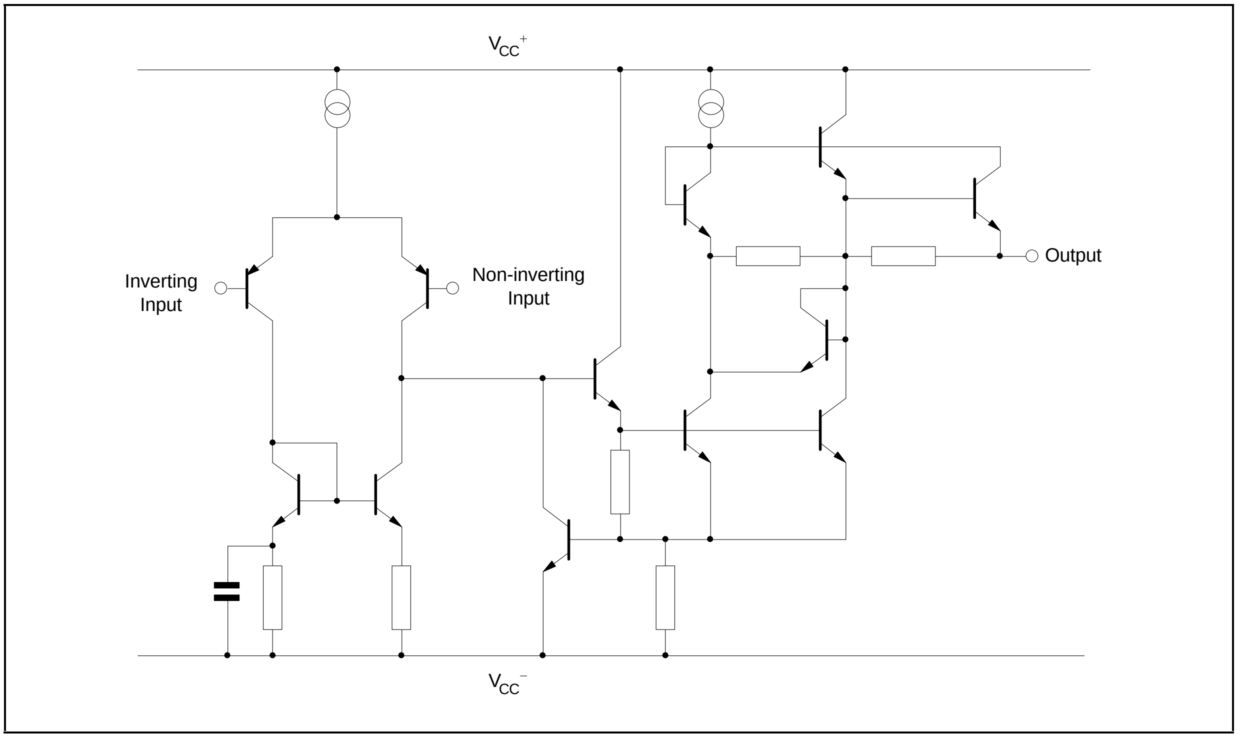
Part Number	Temperature Range	Package	
		N	D
LM833	-40°C, +105°C	•	•

N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel (DT)

PIN CONNECTIONS (top view)



SCHEMATIC DIAGRAM (1/2 LM833)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±18 or +36	V
V_{id}	Differential Input Voltage - note 1)	±30	V
V_i	Input Voltage - see note 1	±15	V
	Output Short Circuit Duration	Infinite	s
T_{oper}	Operating Free-Air Temperature Range	-40 to 105	°C
T_j	Junction Temperature	+150	°C
T_{stg}	Storage Temperature	-65 to +150	°C
Ptot	Maximum Power Dissipation - note 2)	500	mW

1. Either or both input voltages must not exceed the magnitude of Vcc^+ or Vcc^-.
2. Power dissipation must be considered to ensure maximum junction temperature (Tj) is not exceeded.

OPERATING CONDITIONS

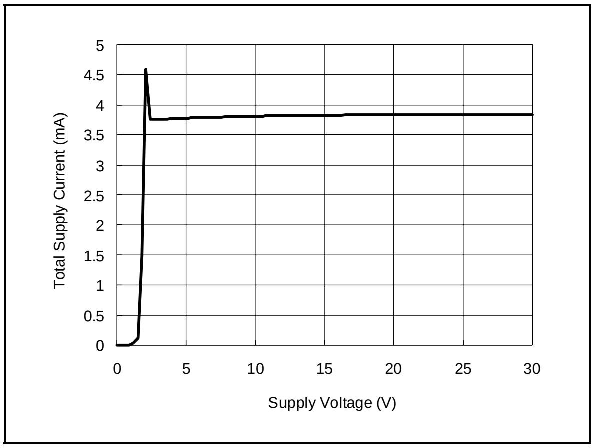
Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±2.5 to ±15	V

ELECTRICAL CHARACTERISTICS

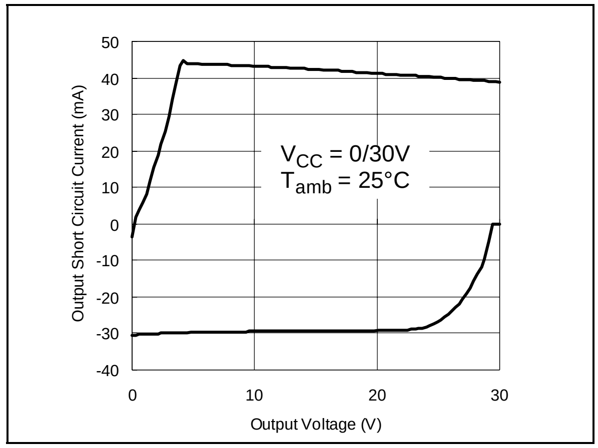
V_{CC}^{+} = +15V, V_{CC}^{-} = -15V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage (R_s = 10Ω, V_o = 0V, V_{ic} = 0V)		0.3	5	mV
DV_{io}	Input Offset Voltage Drift R_s = 10Ω, V_o = 0V, $T_{min.} \le T_{amb} \le T_{max.}$		2		μV/°C
I_{io}	Input Offset Current (V_o = 0V, V_{ic} = 0V)		25	200	nA
I_{ib}	Input Bias Current (V_o = 0V, V_{ic} = 0V)		300	1000	nA
V_{icm}	Input Common Mode Voltage Range	±12	±14		V
A_{vd}	Large Signal Voltage Gain (R_L = 2kΩ, V_o = ±10V)	90	100		dB
$\pm V_{opp}$	Output Voltage Swing (V_{id} = ±1V) R_L = 2.0kΩ R_L = 2.0kΩ R_L = 10kΩ R_L = 10kΩ	10 12 	13.7 -14 13.9 -14.4	 -10 -12	V
CMR	Common-mode Rejection Ratio (V_{ic} = ±13V)	80	100		dB
SVR	Supply Voltage Rejection Ratio (V_{CC}^{+} / V_{CC}^{-} = +15V / -15V to +5V / -5V)	80	105		dB
I_{CC}	Supply Current (V_o = 0V, All amplifiers)		4	8	mA
SR	Slew Rate (V_i = -10V to +10V, R_L = 2kΩ, A_V = +1)	5	7		V/μs
GBP	Gain Bandwidth Product (R_L = 2kΩ, C_L = 100pF, f = 100kHz)	10	15		MHz
B	Unity Gain Bandwidth (Open loop)		9		MHz
ϕm	Phase Margin (R_L = 2kΩ)		60		Degrees
e_n	Equivalent Input Noise Voltage (R_S = 100Ω, f = 1kHz)		4.5		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent Input Noise Current (f = 1kHz)		0.5		$\frac{pA}{\sqrt{Hz}}$
THD	Total Harmonic Distortion (R_L = 2kΩ, f = 20Hz to 20kHz, V_o = 3V_{rms}, A_V = +1)		0.002		%
V_{O1}/V_{O2}	Channel Separation (f = 20Hz to 20kHz)		120		dB
FPB	Full Power Bandwidth (V_o = 27V_{pp}, R_L = 2kΩ, THD ≤ 1%)		120		kHz

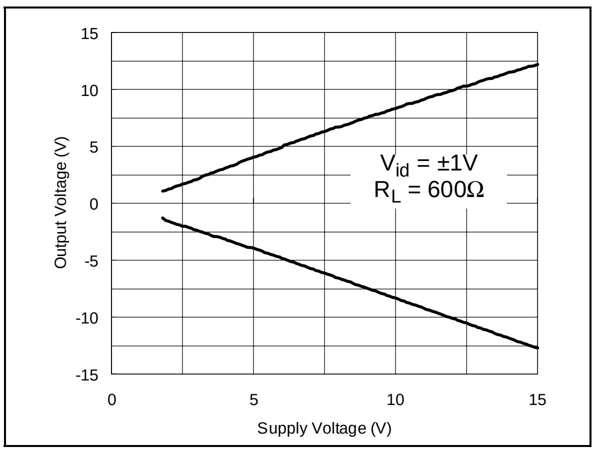
TOTAL SUPPLY CURRENT vs SUPPLY VOLTAGE



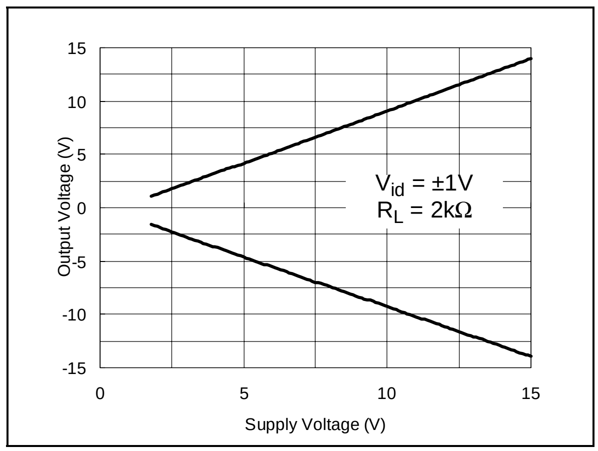
OUTPUT SHORT CIRCUIT CURRENT vs OUTPUT VOLTAGE



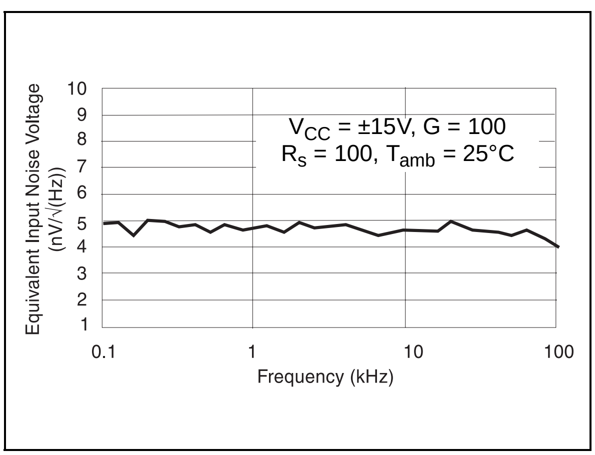
OUTPUT VOLTAGE vs SUPPLY VOLTAGE



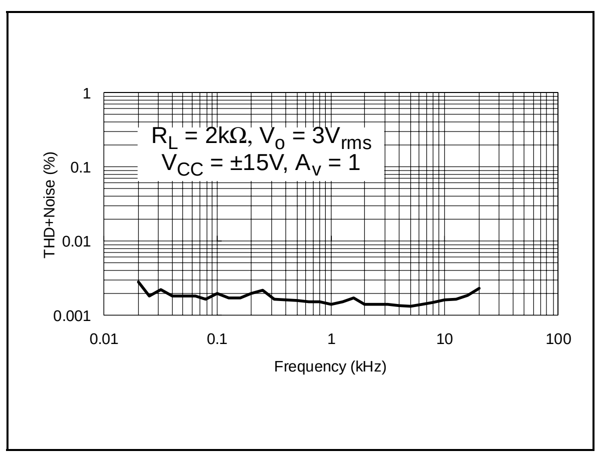
OUTPUT VOLTAGE vs SUPPLY VOLTAGE



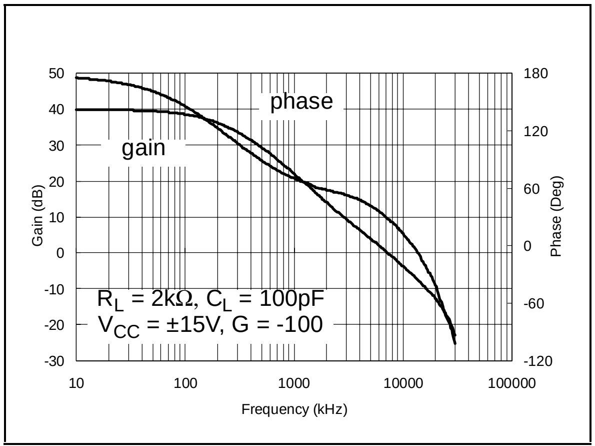
EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY



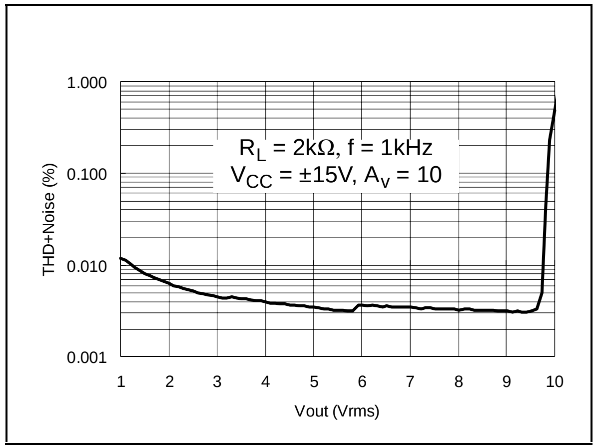
THD + NOISE vs FREQUENCY



VOLTAGE GAIN AND PHASE vs FREQUENCY

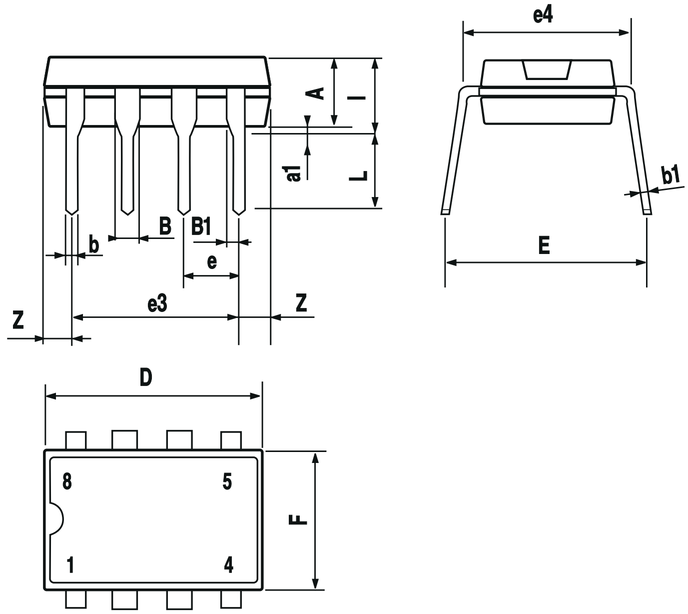


THD + NOISE vs Vout



PACKAGE MECHANICAL DATA

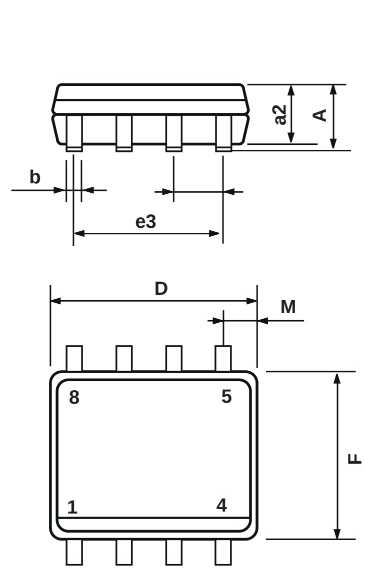
8 PINS - PLASTIC DIP



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

PACKAGE MECHANICAL DATA

8 PINS - PLASTIC MICROPACKAGE (SO)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					