MOTOROLA

MC33076

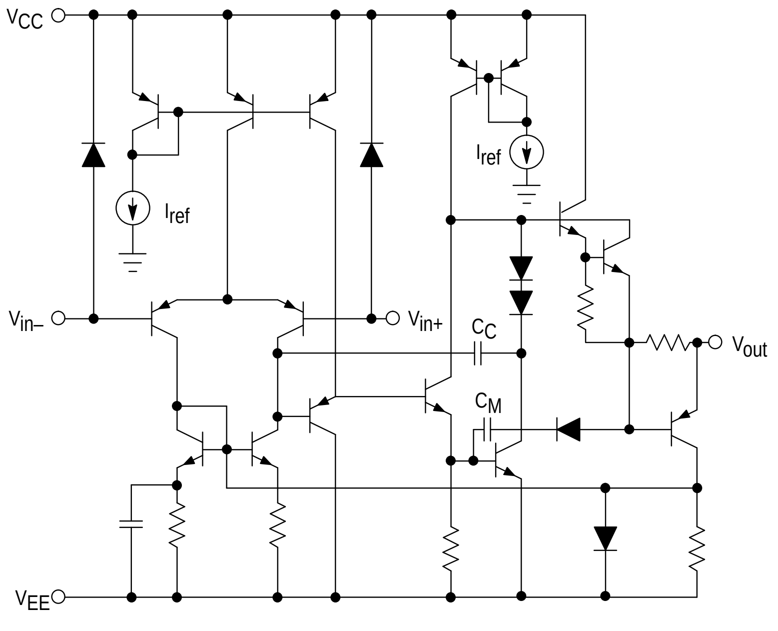
Dual High Output Current, Low Power, Low Noise Bipolar Operational Amplifier

The MC33076 operational amplifier employs bipolar technology with innovative high performance concepts for audio and industrial applications. This device uses high frequency PNP input transistors to improve frequency response. In addition, the amplifier provides high output current drive capability while minimizing the drain current. The all NPN 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 and sink AC frequency performance.

The MC33076 is tested over the automotive temperature range and is available in an 8–pin SOIC package (D suffix) and in both the standard 8 pin DIP and 16–pin DIP packages for high power applications.

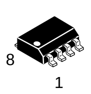
- 100 Ω Output Drive Capability
- Large Output Voltage Swing
- Low Total Harmonic Distortion
- High Gain Bandwidth: 7.4 MHz
- High Slew Rate: 2.6 V/µs
- Dual Supply Operation: ±2.0 V to ±18 V
- High Output Current: ISC = 250 mA typ
- Similar Performance to MC33178

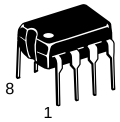
Equivalent Circuit Schematic
(Each Amplifier)



DUAL HIGH OUTPUT CURRENT OPERATIONAL AMPLIFIER

SEMICONDUCTOR TECHNICAL DATA

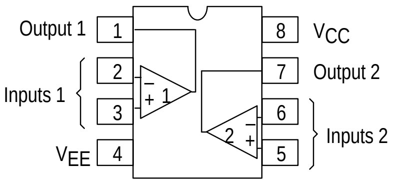




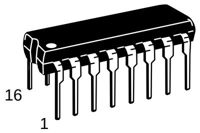
D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO–8)

P1 SUFFIX
PLASTIC PACKAGE
CASE 626

PIN CONNECTIONS

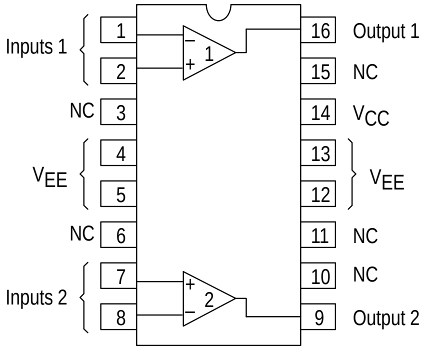


(8 Pin Pkg, Top View)



P2 SUFFIX
PLASTIC PACKAGE
CASE 648C
DIP (12+2+2)

PIN CONNECTIONS



(16 Pin Pkg, Top View)

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33076D	T_A = –40° to +85°C	SO–8
MC33076P1		Plastic DIP
MC33076P2		Power Plastic

Rev 0

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage (Note 2)	V_{CC} to V_{EE}	+36	V
Input Differential Voltage Range	V_{IDR}	(Note 1)	V
Input Voltage Range	V_{IR}	(Note 1)	V
Output Short Circuit Duration (Note 2)	t_{SC}	5.0	sec
Maximum Junction Temperature	T_J	+150	°C
Storage Temperature	T_{stg}	–60 to +150	°C
Maximum Power Dissipation	P_D	(Note 2)	mW

NOTES: 1. Either or both input voltages should not exceed 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, Figure 1). See applications section for further information.

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

Characteristics	Figure	Symbol	Min	Typ	Max	Unit
Input Offset Voltage (R_S = 50 Ω, V_{CM} = 0 V)	2	$\|V_{IO}\|$				mV
(V_S = ±2.5 V to ±15 V)						
T_A = +25°C			—	0.5	4.0	
T_A = –40° to +85°C			—	0.5	5.0	
Input Offset Voltage Temperature Coefficient		$\Delta V_{IO}/\Delta T$				μV/°C
(R_S = 50 Ω, V_{CM} = 0 V)						
T_A = –40° to +85°C			—	2.0	—	
Input Bias Current (V_{CM} = 0 V)	3, 4	I_{IB}				nA
T_A = +25°C			—	100	500	
T_A = –40° to +85°C			—	—	600	
Input Offset Current (V_{CM} = 0 V)		$\|I_{IO}\|$				nA
T_A = +25°C			—	5.0	70	
T_A = –40° to +85°C			—	—	100	
Common Mode Input Voltage Range	5	V_{ICR}	–13	–14		V
				+14	13	
Large Signal Voltage Gain (V_O = –10 V to +10 V)	6	A_{VOL}				kV/V
(T_A = +25°C)						
R_L = 100 Ω			25	—	—	
R_L = 600 Ω			50	200	—	
(T_A = –40° to +85°C)						
R_L = 600 Ω			25	—	—	
Output Voltage Swing (V_{ID} = ±1.0 V)	7, 8, 9					V
(V_{CC} = +15 V, V_{EE} = –15 V)						
R_L = 100 Ω		V_{O+}	10	+11.7	—	
R_L = 100 Ω		V_{O-}	—	–11.7	–10	
R_L = 600 Ω		V_{O+}	13	+13.8	—	
R_L = 600 Ω		V_{O-}	—	–13.8	–13	
(V_{CC} = +2.5 V, V_{EE} = –2.5 V)						
R_L = 100 Ω		V_{O+}	1.2	+1.66	—	
R_L = 100 Ω		V_{O-}	—	–1.74	–1.2	
Common Mode Rejection (V_{in} = ±13 V)	10	CMR	80	116	—	dB
Power Supply Rejection	11	PSR				dB
(V_{CC}/V_{EE} = +15 V/–15 V, +5.0 V/–15 V, +15 V/–5.0 V)			80	120	—	

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

Characteristics	Figure	Symbol	Min	Typ	Max	Unit
Output Short Circuit Current (V_{ID} = ±1.0 V Output to Gnd)	12, 13	I_{SC}				mA
(V_{CC} = +15 V, V_{EE} = –15 V)						
Source			190	+250	—	
Sink			—	–280	–215	
(V_{CC} = +2.5 V, V_{EE} = –2.5 V)						
Source			63	+94	—	
Sink			—	–80	–46	
Power Supply Current per Amplifier (V_O = 0 V)	14	I_D				mA
(V_S = ±2.5 V to ±15 V)						
T_A = +25°C			—	2.2	2.8	
T_A = –40° to +85°C			—	—	3.3	

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

Characteristics	Figure	Symbol	Min	Typ	Max	Unit
Slew Rate (V_{in} = –10 V to +10 V, R_L = 100 Ω, C_L = 100 pF, A_V = +1)	15	SR	1.2	2.6	—	V/µs
Gain Bandwidth Product (f = 20 kHz)	16	GBW	4.0	7.4	—	MHz
Unity Gain Frequency (Open Loop) (R_L = 600 Ω, C_L = 0 pF)	—	f_U	—	3.5	—	MHz
Gain Margin (R_L = 600 Ω, C_L = 0 pF)	19, 20	A_m	—	15	—	dB
Phase Margin (R_L = 600 Ω, C_L = 0 pF)	19, 20	$\varnothing_m$	—	52	—	Deg
Channel Separation (f = 100 Hz to 20 kHz)	21	CS	—	–120	—	dB
Power Bandwidth (V_O = 20 V_{pp}, R_L = 600 Ω, THD ≤ 1%)	—	BW_p	—	32	—	kHz
Total Harmonic Distortion (R_L = 600 Ω, V_O = 2.0 V_{pp}, A_V = +1)	22	THD				%
f = 1.0 kHz			—	0.0027	—	
f = 10 kHz			—	0.011	—	
f = 20 kHz			—	0.022	—	
Open Loop Output Impedance (V_O = 0 V, f = 2.5 MHz, A_V = 10)	23	$\lvert Z_O \rvert$	—	75	—	Ω
Differential Input Resistance (V_{CM} = 0 V)	—	R_{in}	—	200	—	kΩ
Differential Input Capacitance (V_{CM} = 0 V)	—	C_{in}	—	10	—	pF
Equivalent Input Noise Voltage (R_S = 100 Ω)	24	e_n				nV/$\sqrt{Hz}$
f = 10 Hz			—	7.5		
f = 1.0 kHz			—	5.0	—	
Equivalent Input Noise Current	—	i_n				pA/$\sqrt{Hz}$
f = 10 Hz			—	0.33	—	
f = 1.0 kHz			—	0.15	—	

Figure 1. Maximum Power Dissipation versus Temperature

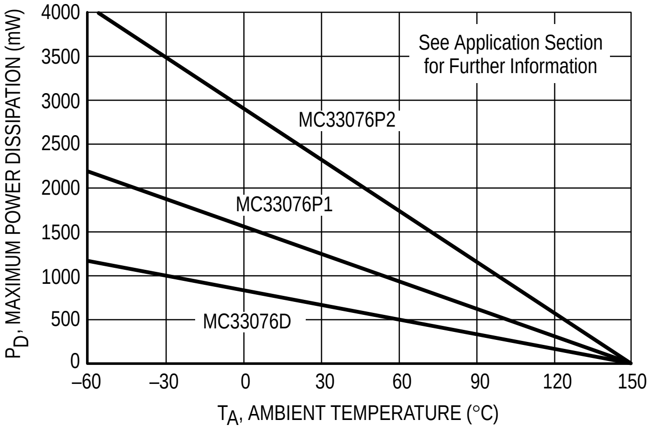


Figure 2. Distribution of Input Offset Voltage

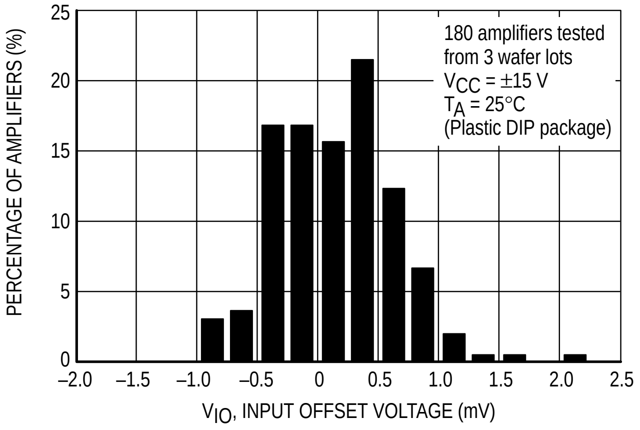


Figure 3. Input Bias Current versus Common Mode Voltage

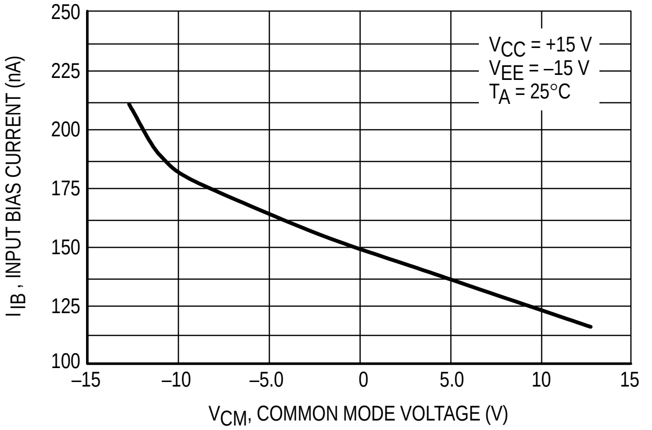


Figure 4. Input Bias Current versus Temperature

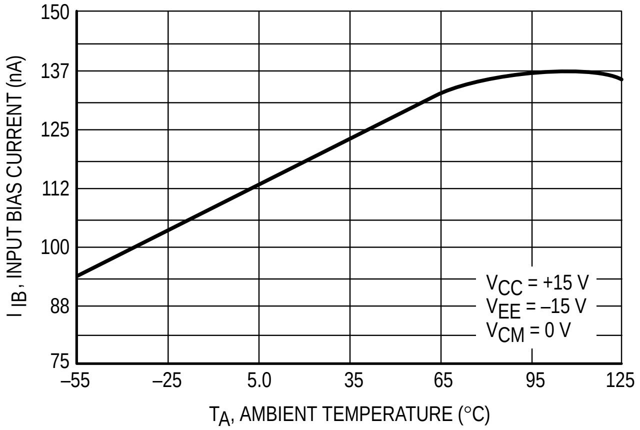


Figure 5. Input Common Mode Voltage Range versus Temperature

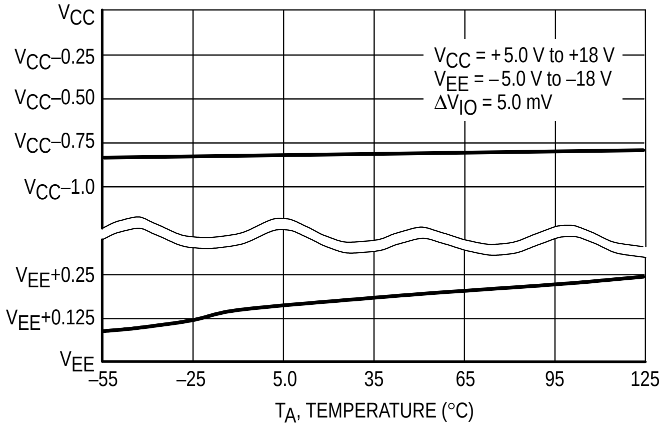


Figure 6. Open Loop Voltage Gain versus Temperature

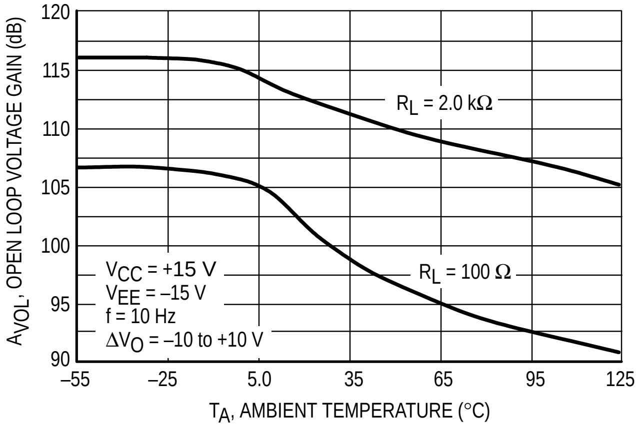


Figure 7. Output Voltage Swing versus Supply Voltage

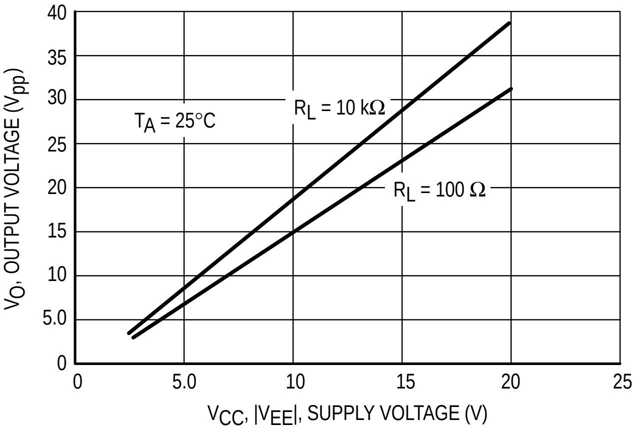


Figure 8. Maximum Peak–to–Peak Output Voltage Swing versus Load Resistance

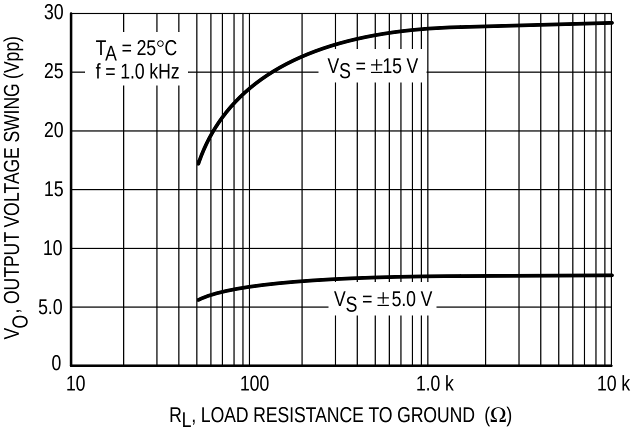


Figure 9. Output Voltage versus Frequency

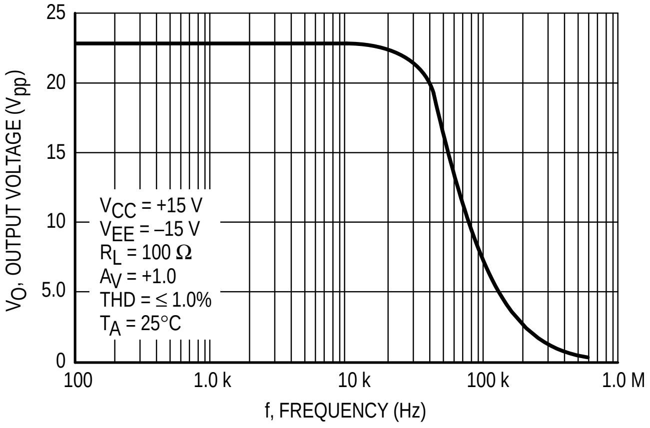


Figure 10. Common Mode Rejection versus Frequency Over Temperature

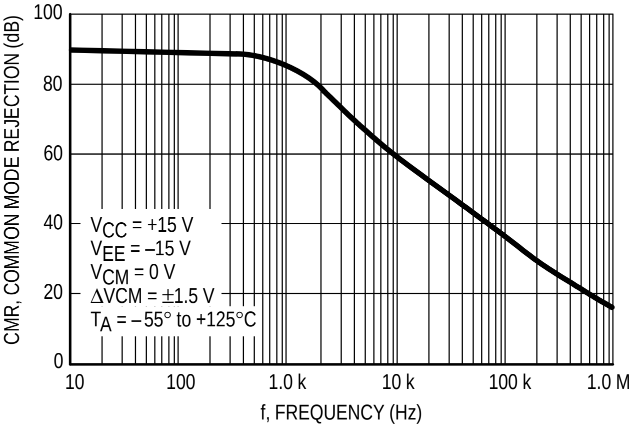


Figure 11. Power Supply Rejection versus Frequency Over Temperature

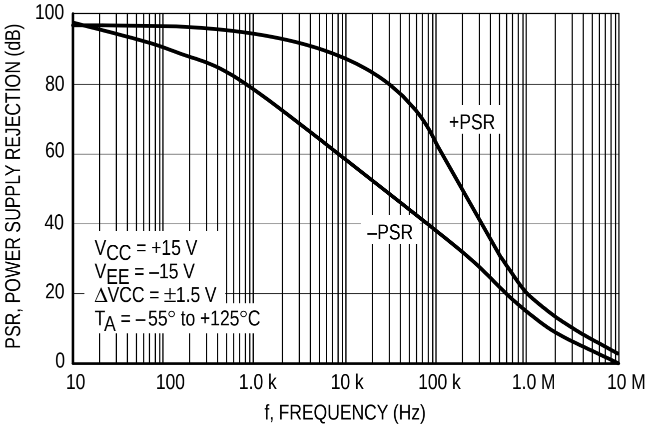


Figure 12. Output Short Circuit Current versus Output Voltage

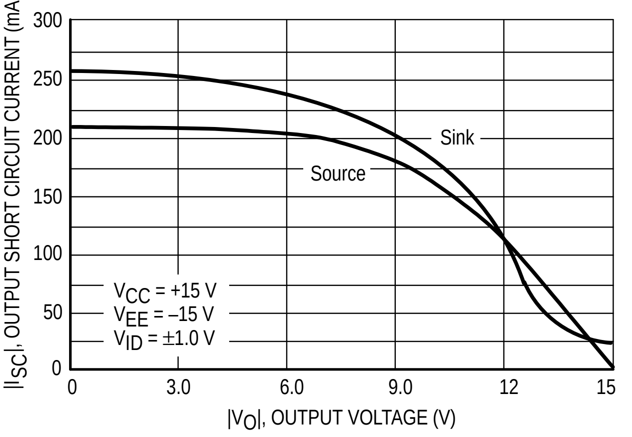


Figure 13. Output Short Circuit Current versus Temperature

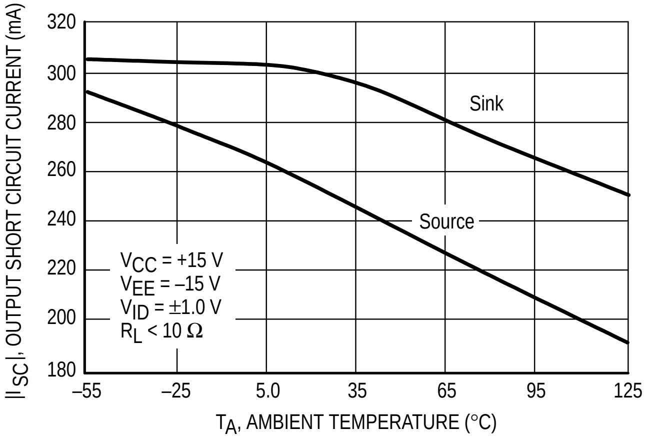


Figure 14. Supply Current versus Supply Voltage with No Load

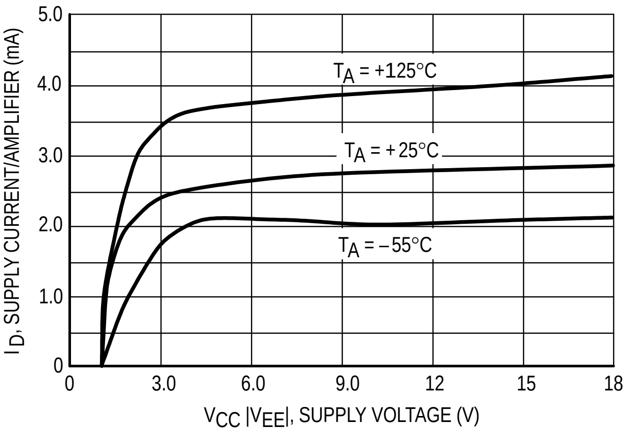


Figure 15. Slew Rate versus Temperature

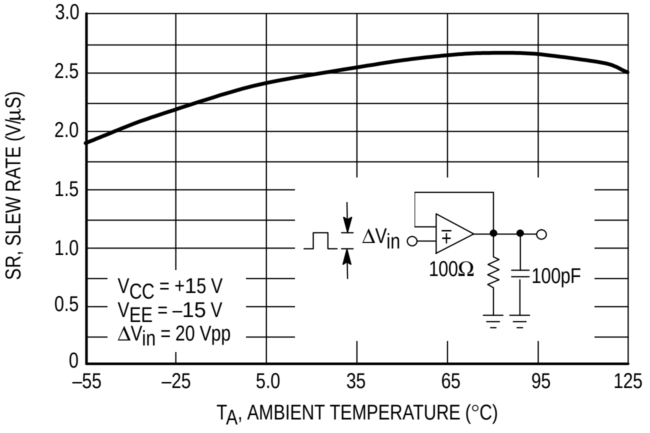


Figure 16. Gain Bandwidth Product versus Temperature

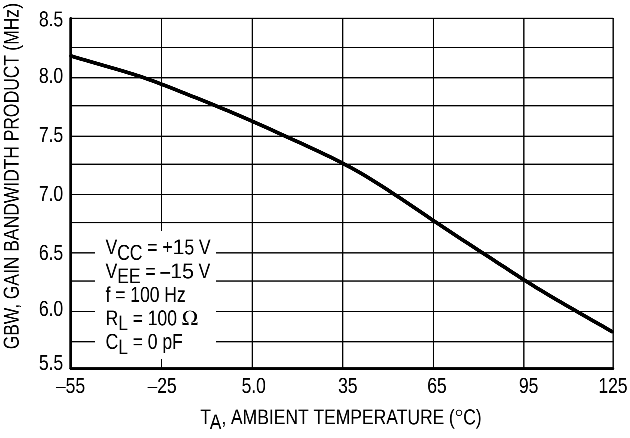


Figure 17. Voltage Gain and Phase versus Frequency

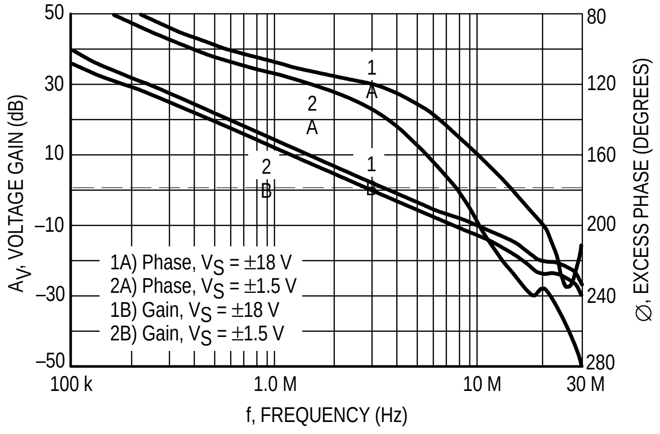


Figure 18. Voltage Gain and Phase versus Frequency

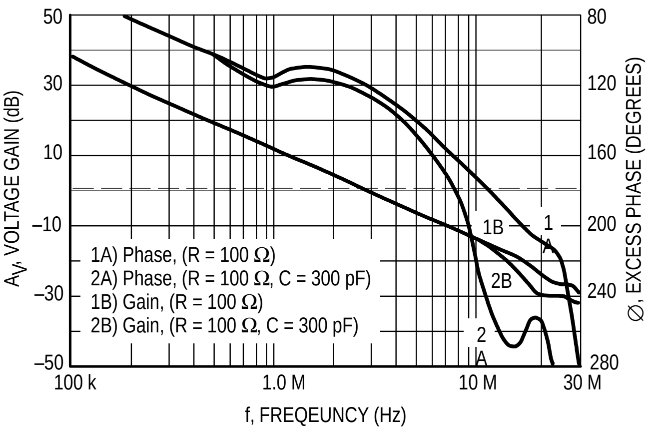


Figure 19. Phase Margin and Gain Margin versus Differential Source Resistance

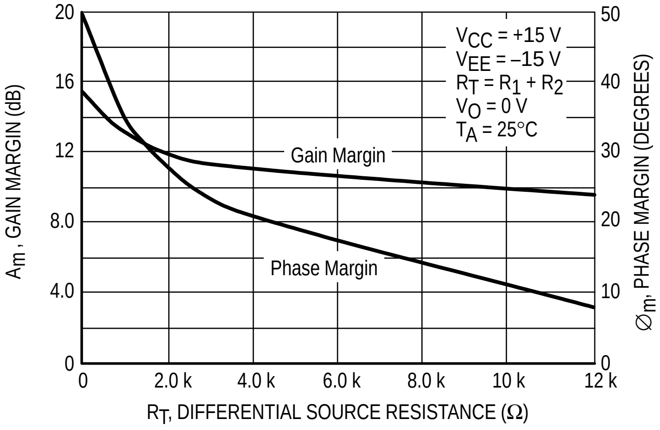


Figure 20. Open Loop Gain Margin and Phase Margin versus Output Load Capacitance

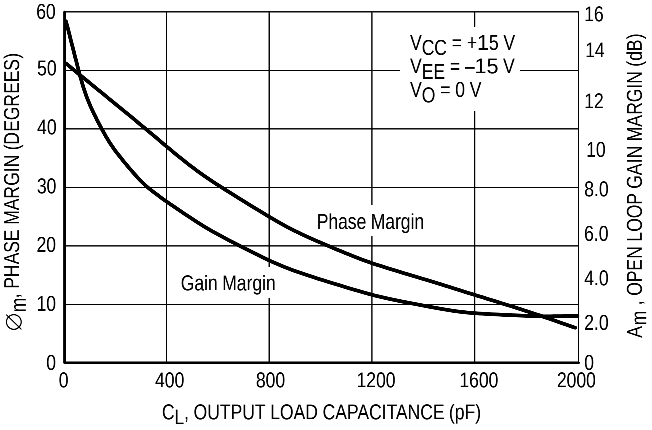


Figure 21. Channel Separation versus Frequency

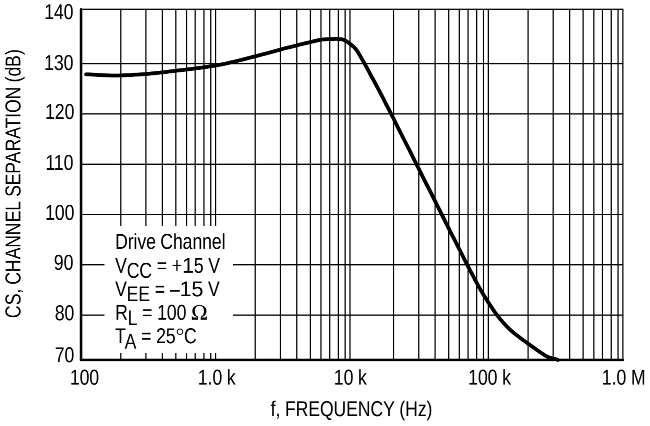


Figure 22. Total Harmonic Distortion versus Frequency

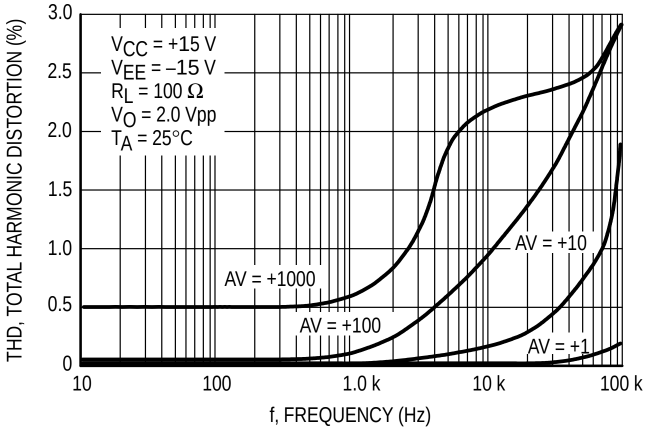


Figure 23. Output Impedance versus Frequency

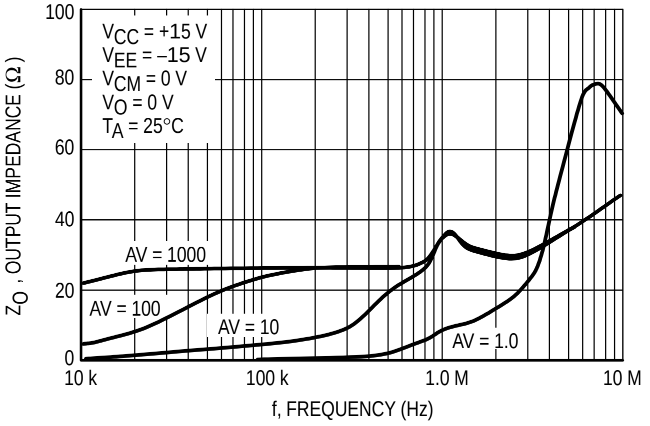


Figure 24. Input Referred Noise Voltage versus Frequency

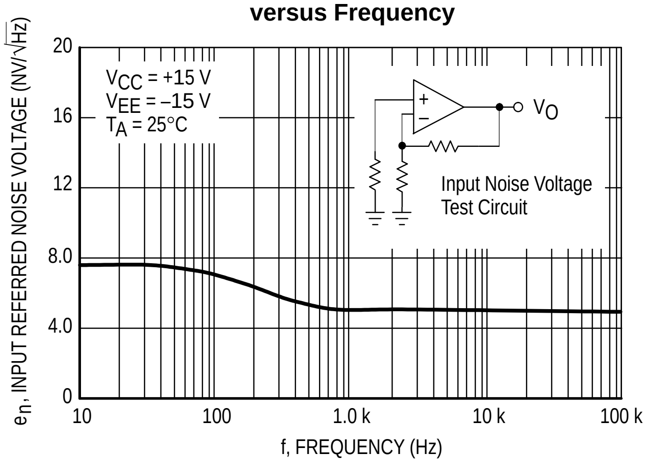


Figure 25. Percent Overshoot versus Load Capacitance

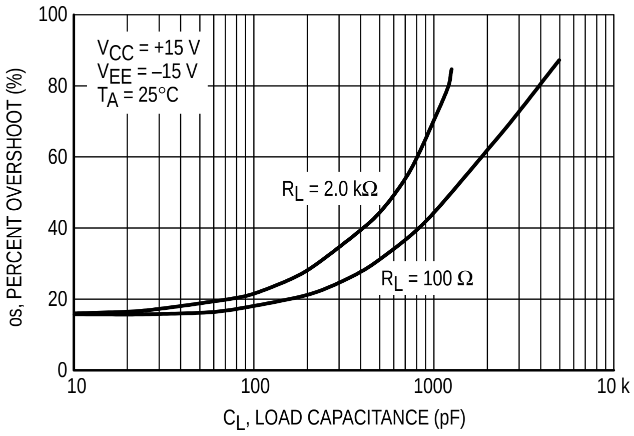
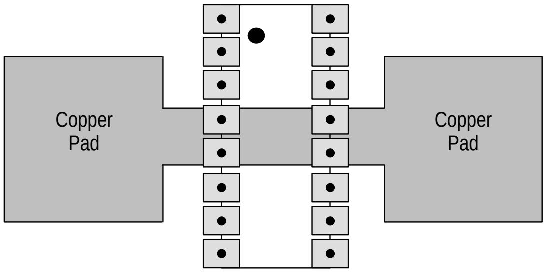


Figure 26. PC Board Heatsink Example

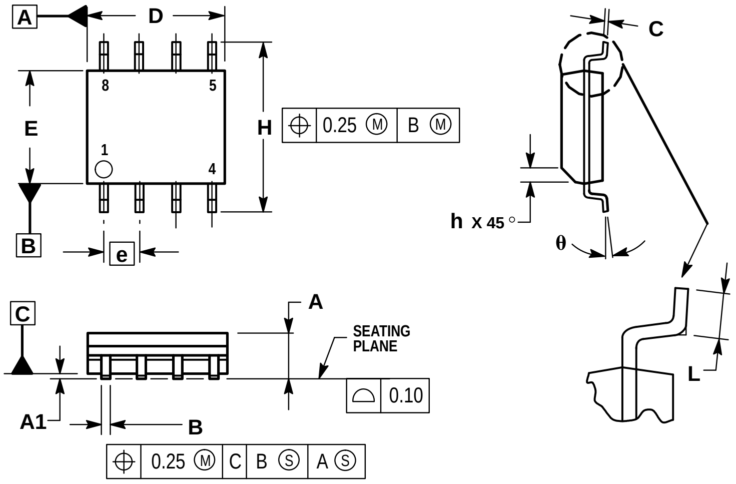


APPLICATIONS INFORMATION

The MC33076 dual operational amplifier is available in the standard 8–pin plastic dual–in–line (DIP) and surface mount packages, and also in a 16–pin batwing power package. To enhance the power dissipation capability of the power package, Pins 4, 5, 12, and 13 are tied together on the leadframe, giving it an ambient thermal resistance of 52°C/W typically, in still air. The junction–to–ambient thermal resistance ($R_{\theta JA}$) can be decreased further by using a copper padb on the printed circuit board (as shown in Figure 26) to draw the heat away from the package. *Care must be taken not to exceed the maximum junction temperature or damage to the device may occur.*

OUTLINE DIMENSIONS

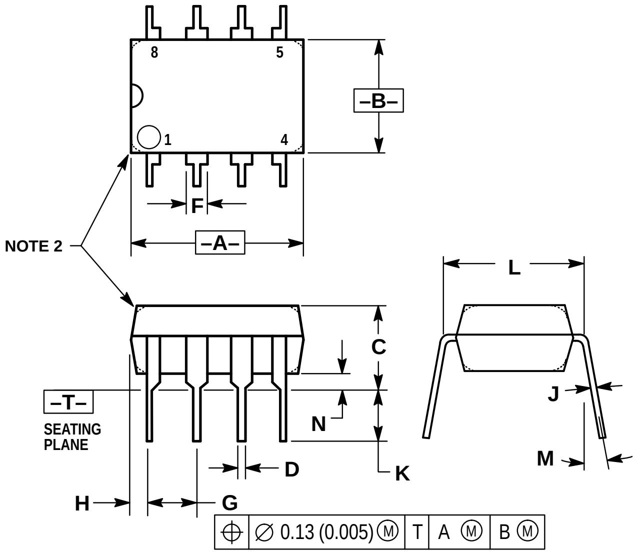
D SUFFIX
PLASTIC PACKAGE
CASE 751–05
(SO–8)
ISSUE R



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°

P1 SUFFIX
PLASTIC PACKAGE
CASE 626–05
ISSUE K

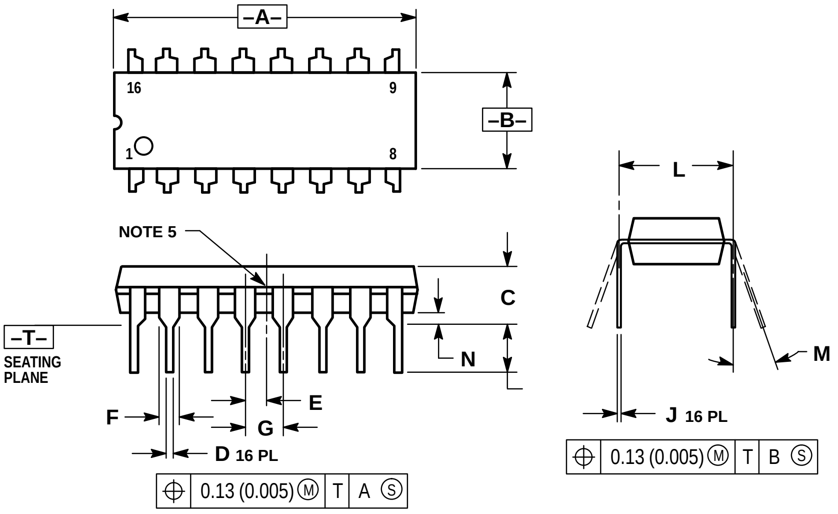


NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

	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

OUTLINE DIMENSIONS

P2 SUFFIX
PLASTIC PACKAGE
CASE 648C–03
(DIP (12+2+2))
ISSUE C



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. INTERNAL LEAD CONNECTION BETWEEN 4 AND 5, 12 AND 13.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.740	0.840	18.80	21.34
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
E	0.050 BSC		1.27 BSC	
F	0.040	0.70	1.02	1.78
G	0.100 BSC		2.54 BSC	
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0°	10°	0°	10°
N	0.015	0.040	0.39	1.01

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3–14–2 Tatsumi Koto–Ku, Tokyo 135, Japan. 03–81–3521–8315

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