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MOTOROLA

MC33078
MC33079

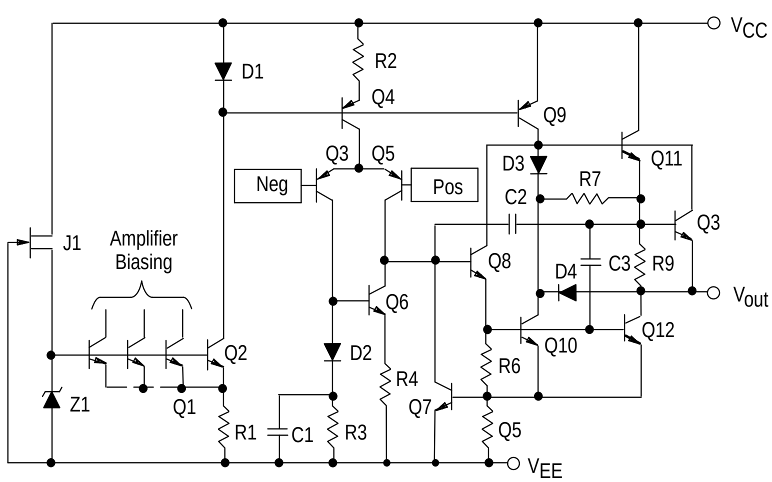
Dual/Quad Low Noise Operational Amplifiers

The MC33078/9 series is a family of high quality monolithic amplifiers employing Bipolar technology with innovative high performance concepts for quality audio and data signal processing applications. This family incorporates the use of high frequency PNP input transistors to produce amplifiers exhibiting low input voltage noise with high gain bandwidth product and slew rate. 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 MC33078/9 family offers both dual and quad amplifier versions, tested over the automotive temperature range and available in the plastic DIP and SOIC packages (P and D suffixes).

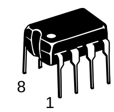
- Dual Supply Operation: ±5.0 V to ±18 V
- Low Voltage Noise: 4.5 nV/$\sqrt{\text{Hz}}$
- Low Input Offset Voltage: 0.15 mV
- Low T.C. of Input Offset Voltage: 2.0 µV/°C
- Low Total Harmonic Distortion: 0.002%
- High Gain Bandwidth Product: 16 MHz
- High Slew Rate: 7.0 V/µs
- High Open Loop AC Gain: 800 @ 20 kHz
- Excellent Frequency Stability
- Large Output Voltage Swing: +14.1 V/ –14.6 V
- ESD Diodes Provided on the Inputs

Representative Schematic Diagram
(Each Amplifier)

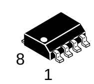


DUAL/QUAD LOW NOISE OPERATIONAL AMPLIFIERS

DUAL

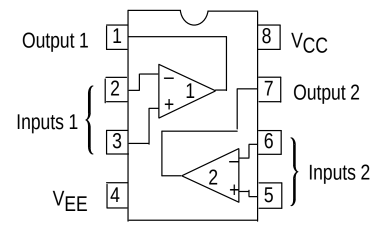


P SUFFIX
PLASTIC PACKAGE
CASE 626



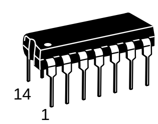
D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO–8)

PIN CONNECTIONS

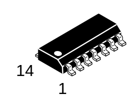


(Dual, Top View)

QUAD

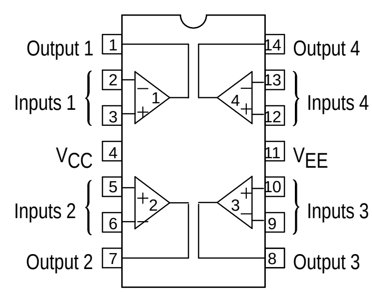


P SUFFIX
PLASTIC PACKAGE
CASE 646



D SUFFIX
PLASTIC PACKAGE
CASE 751A
(SO–14)

PIN CONNECTIONS



(Quad, Top View)

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33078D	T_A = –40° to +85°C	SO–8
MC33078P		Plastic DIP
MC33079D		SO–14
MC33079P		Plastic DIP

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage (V_{CC} to V_{EE})	V_S	+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}	Indefinite	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 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 Figure 1).

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

Characteristics	Symbol	Min	Typ	Max	Unit
Input Offset Voltage (R_S = 10 Ω, V_{CM} = 0 V, V_O = 0 V) (MC33078) T_A = +25°C T_A = –40° to +85°C (MC33079) T_A = +25°C T_A = –40° to +85°C	$\|V_{IO}\|$	 — — — —	 0.15 — 0.15 —	 2.0 3.0 2.5 3.5	mV
Average Temperature Coefficient of Input Offset Voltage R_S = 10 Ω, V_{CM} = 0 V, V_O = 0 V, T_A = T_{low} to T_{high}	$\Delta V_{IO}/\Delta T$	—	2.0	—	µV/°C
Input Bias Current (V_{CM} = 0 V, V_O = 0 V) T_A = +25°C T_A = –40° to +85°C	I_{IB}	 — —	 300 —	 750 800	nA
Input Offset Current (V_{CM} = 0 V, V_O = 0 V) T_A = +25°C T_A = –40° to +85°C	I_{IO}	 — —	 25 —	 150 175	nA
Common Mode Input Voltage Range (ΔV_{IO} = 5.0 mV, V_O = 0 V)	V_{ICR}	±13	±14	—	V
Large Signal Voltage Gain (V_O = ±10 V, R_L = 2.0 kΩ) T_A = +25°C T_A = –40° to +85°C	A_{VOL}	 90 85	 110 —	 — —	dB
Output Voltage Swing (V_{ID} = ±1.0V) R_L = 600 Ω R_L = 600 Ω R_L = 2.0 kΩ R_L = 2.0 kΩ R_L = 10 kΩ R_L = 10 kΩ	 V_O+ V_O- V_O+ V_O- V_O+ V_O-	 — — +13.2 — +13.5 —	 +10.7 –11.9 +13.8 –13.7 +14.1 –14.6	 — — — –13.2 — –14	V
Common Mode Rejection (V_{in} = ±13V)	CMR	80	100	—	dB
Power Supply Rejection (Note 3) V_{CC}/V_{EE} = +15 V/ –15 V to +5.0 V/ –5.0 V	PSR	80	105	—	dB
Output Short Circuit Current (V_{ID} = 1.0 V, Output to Ground) Source Sink	I_{SC}	 +15 –20	 +29 –37	 — —	mA
Power Supply Current (V_O = 0 V, All Amplifiers) (MC33078) T_A = +25°C T_A = –40° to +85°C (MC33079) T_A = +25°C T_A = –40° to +85°C	I_D	 — — — —	 4.1 — 8.4 —	 5.0 5.5 10 11	mA

NOTE: 3. Measured with V_{CC} and V_{EE} differentially varied simultaneously.

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

Characteristics		Symbol	Min	Typ	Max	Unit
Slew Rate (V_{in} = –10 V to +10 V, R_L = 2.0 kΩ, C_L = 100 pF A_V = +1.0)		SR	5.0	7.0	—	V/µs
Gain Bandwidth Product (f = 100 kHz)		GBW	10	16	—	MHz
Unity Gain Frequency (Open Loop)		f_U	—	9.0	—	MHz
Gain Margin (R_L = 2.0 kΩ)	C_L = 0 pF C_L = 100 pF	A_m	— —	–11 –6.0	—	dB
Phase Margin (R_L = 2.0 kΩ)	C_L = 0 pF C_L = 100 pF	ϕ_m	— —	55 40	—	Degrees
Channel Separation (f = 20 Hz to 20 kHz)		CS	—	–120	—	dB
Power Bandwidth (V_O = 27 V_{pp}, R_L = 2.0 kΩ, THD ≤ 1.0%)		BW_p	—	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	—	%
Open Loop Output Impedance (V_O = 0 V, f = 9.0 MHz)		$\|Z_O\|$	—	37	—	Ω
Differential Input Resistance (V_{CM} = 0 V)		R_{IN}	—	175	—	kΩ
Differential Input Capacitance (V_{CM} = 0 V)		C_{IN}	—	12	—	pF
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	—	$pA/\sqrt{Hz}$

Figure 1. Maximum Power Dissipation versus Temperature

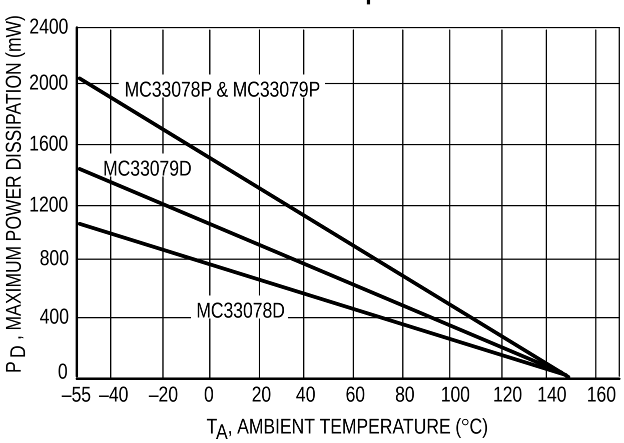


Figure 2. Input Bias Current versus Supply Voltage

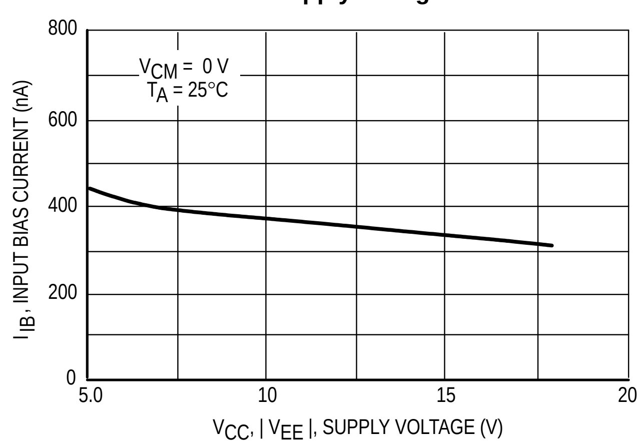


Figure 3. Input Bias Current versus Temperature

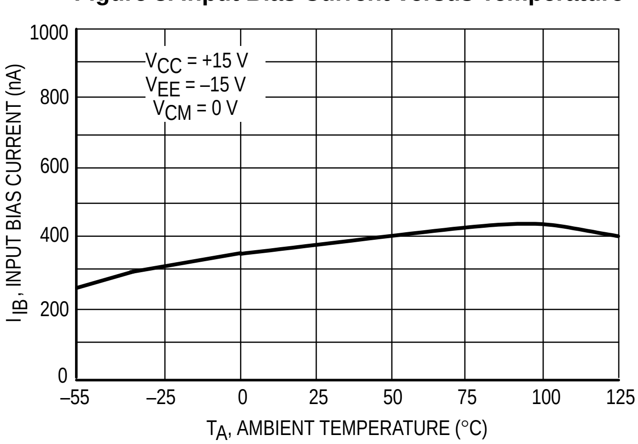


Figure 4. Input Offset Voltage versus Temperature

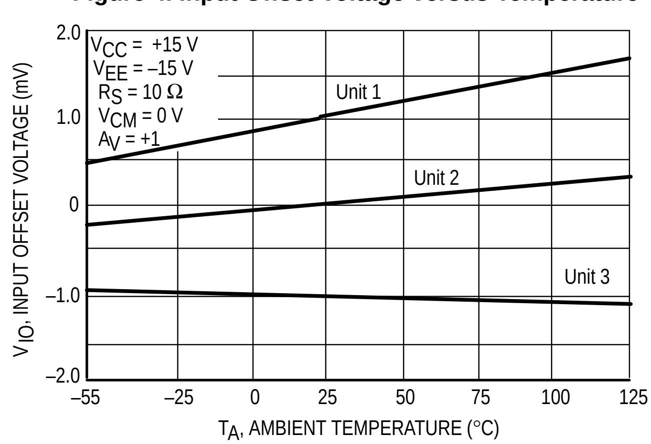


Figure 5. Input Bias Current versus Common Mode Voltage

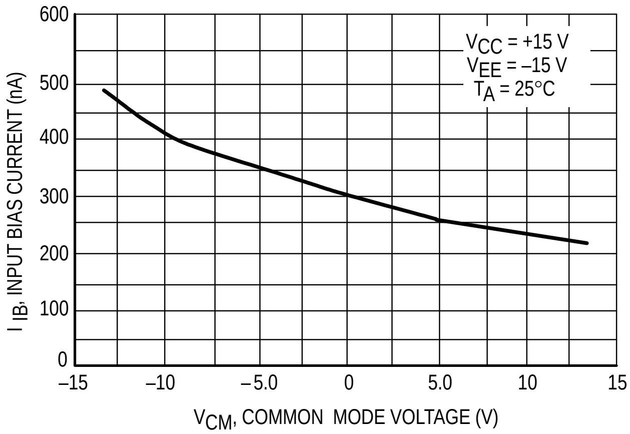


Figure 6. Input Common Mode Voltage Range versus Temperature

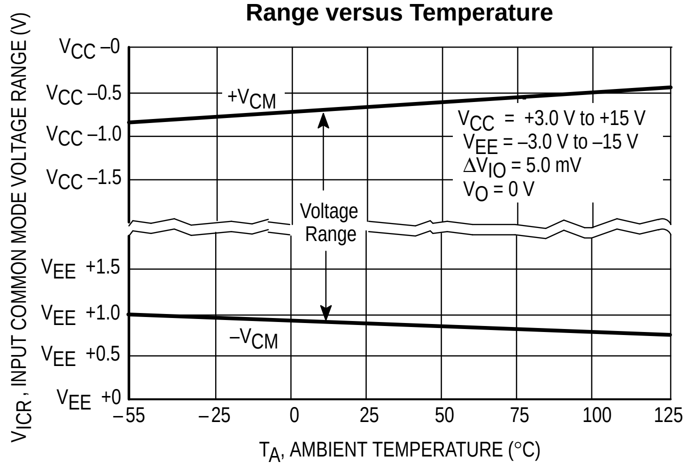


Figure 7. Output Saturation Voltage versus Load Resistance to Ground

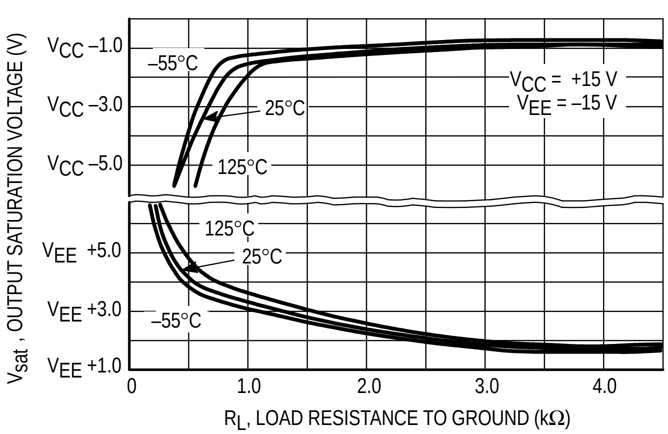


Figure 8. Output Short Circuit Current versus Temperature

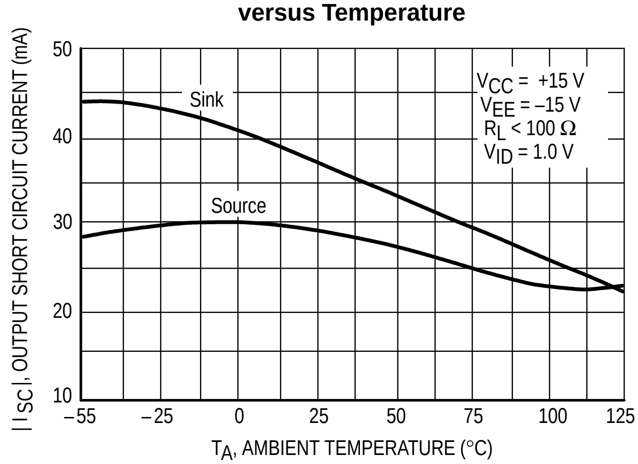


Figure 9. Supply Current versus Temperature

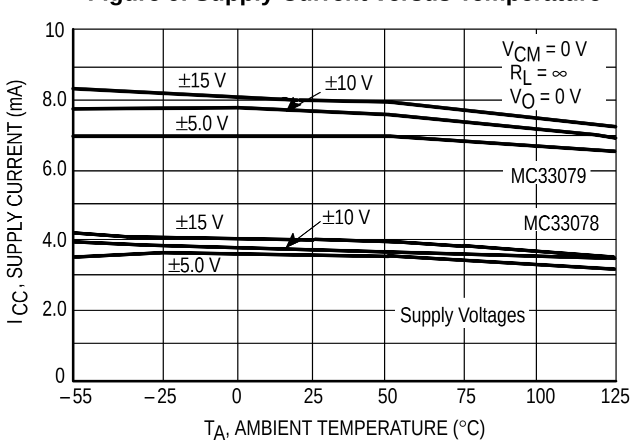


Figure 10. Common Mode Rejection versus Frequency

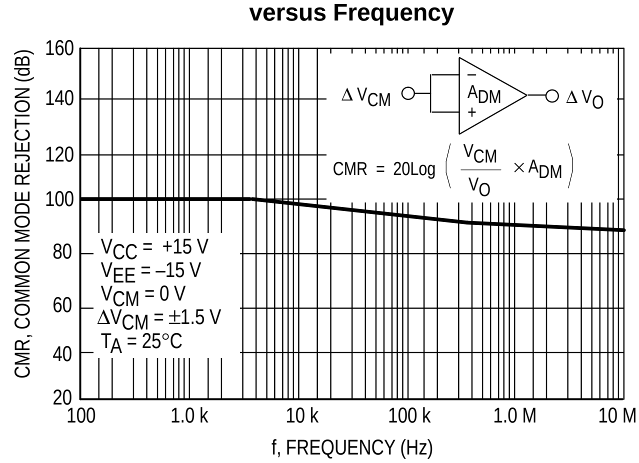


Figure 11. Power Supply Rejection versus Frequency

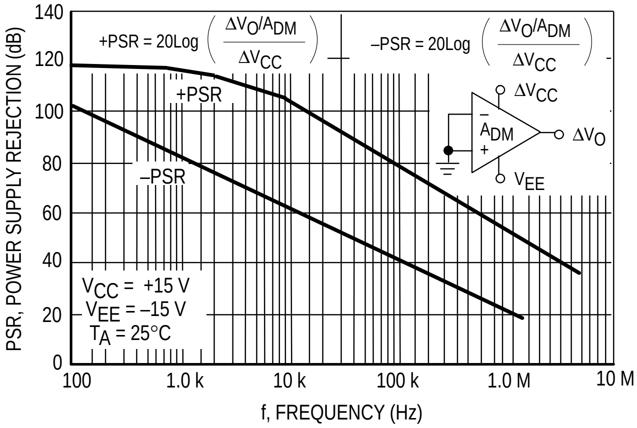


Figure 12. Gain Bandwidth Product versus Supply Voltage

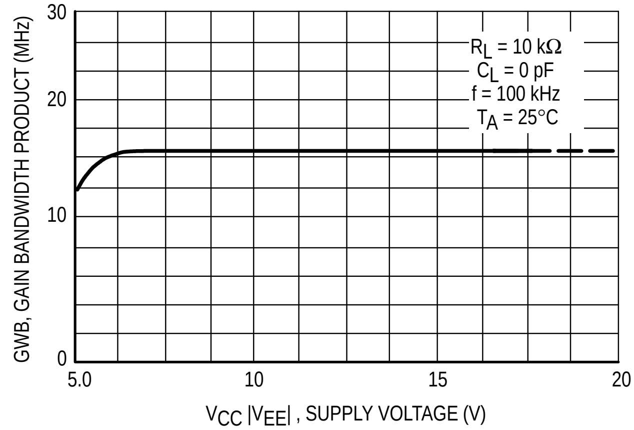


Figure 13. Gain Bandwidth Product versus Temperature

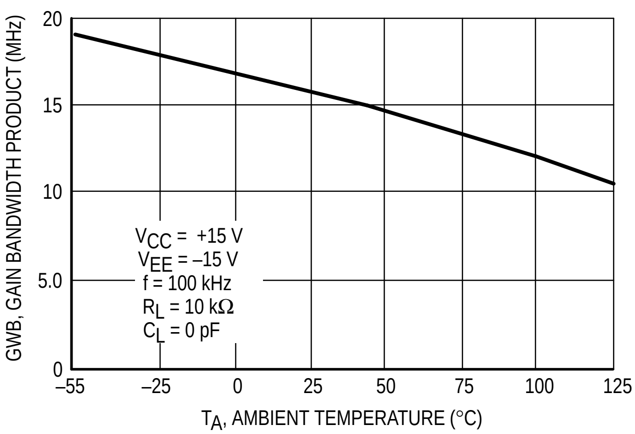


Figure 14. Maximum Output Voltage versus Supply Voltage

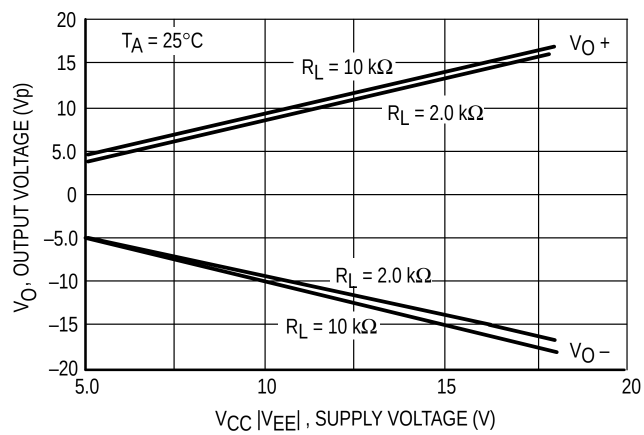


Figure 15. Output Voltage versus Frequency

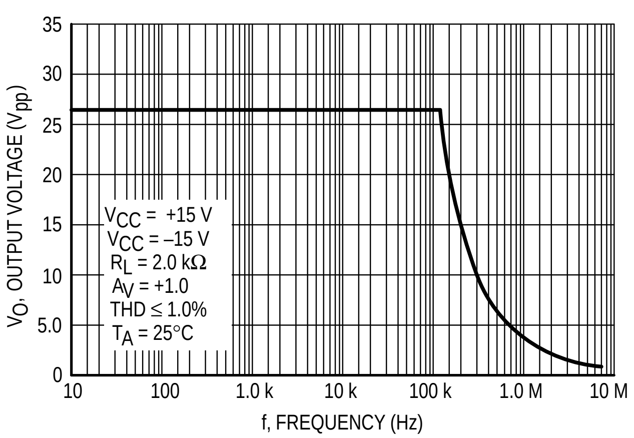


Figure 16. Open Loop Voltage Gain versus Supply Voltage

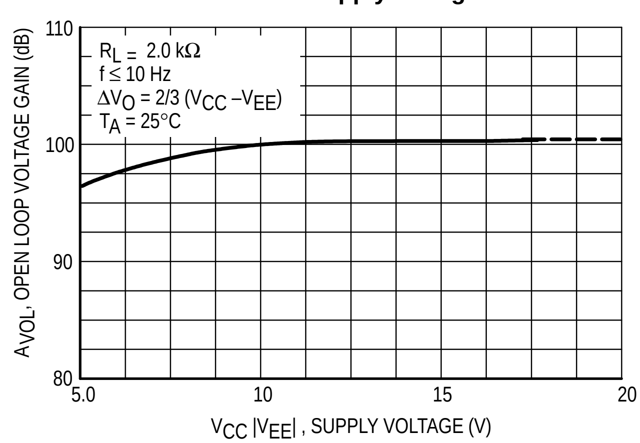


Figure 17. Open Loop Voltage Gain versus Temperature

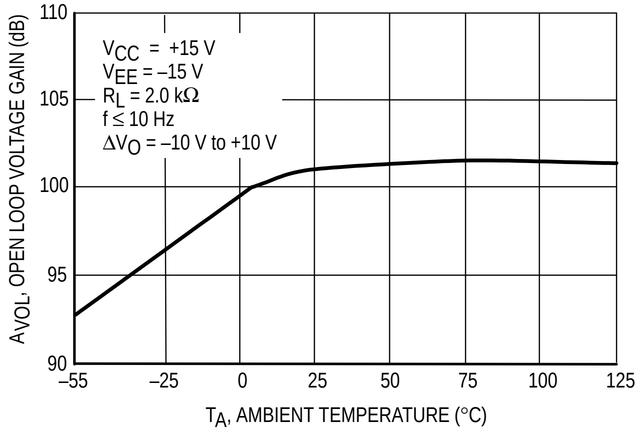


Figure 18. Output Impedance versus Frequency

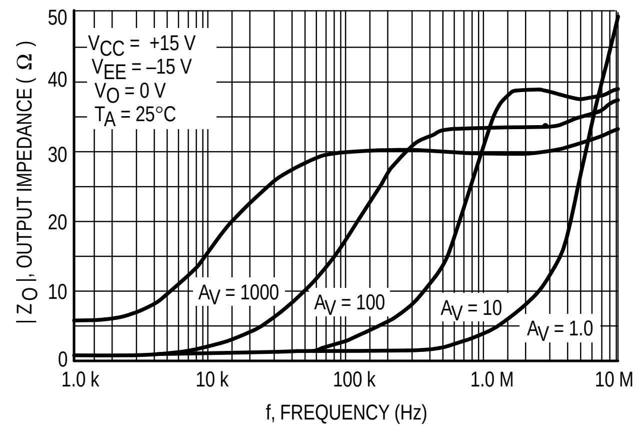


Figure 19. Channel Separation versus Frequency

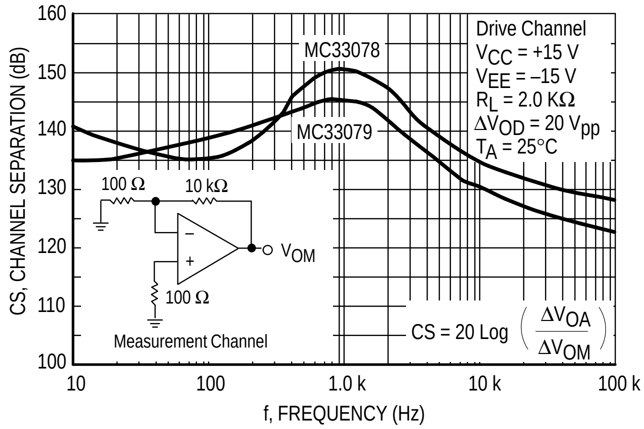


Figure 20. Total Harmonic Distortion versus Frequency

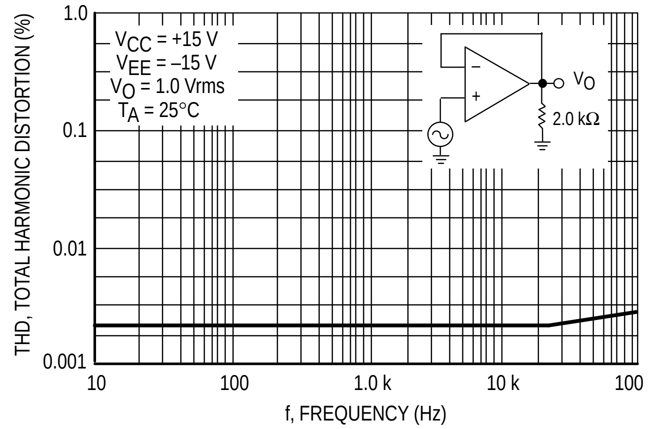


Figure 21. Total Harmonic Distortion versus Output Voltage

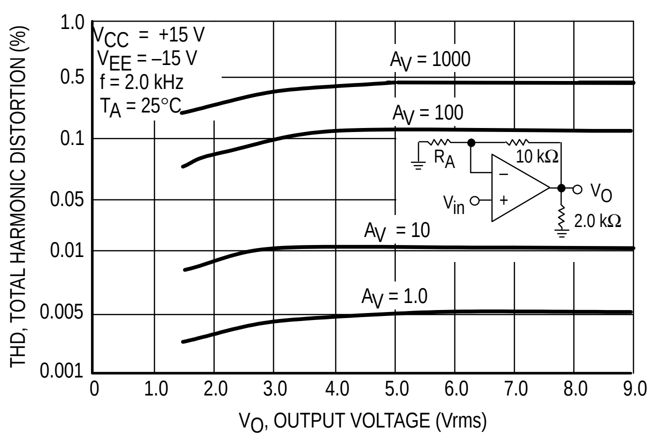


Figure 22. Slew Rate versus Supply Voltage

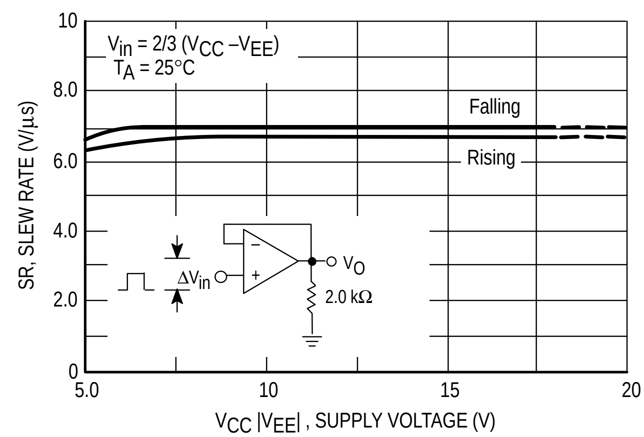


Figure 23. Slew Rate versus Temperature

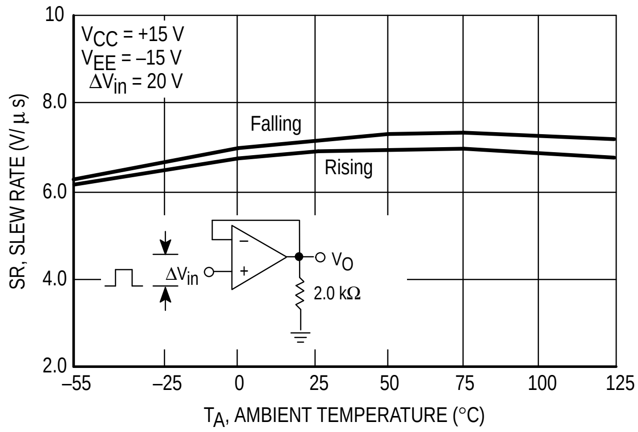


Figure 24. Voltage Gain and Phase versus Frequency

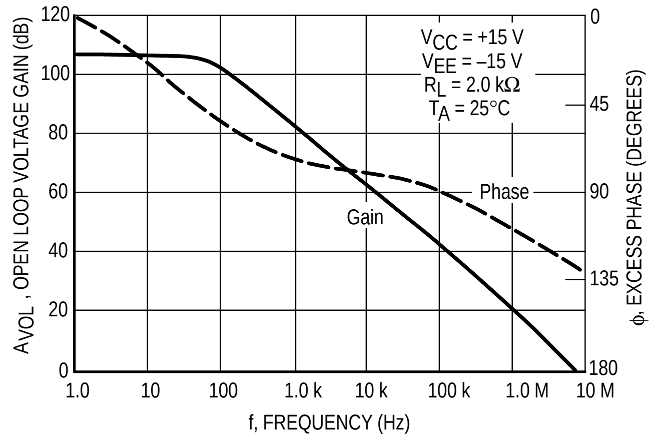


Figure 25. Open Loop Gain Margin and Phase Margin versus Load Capacitance

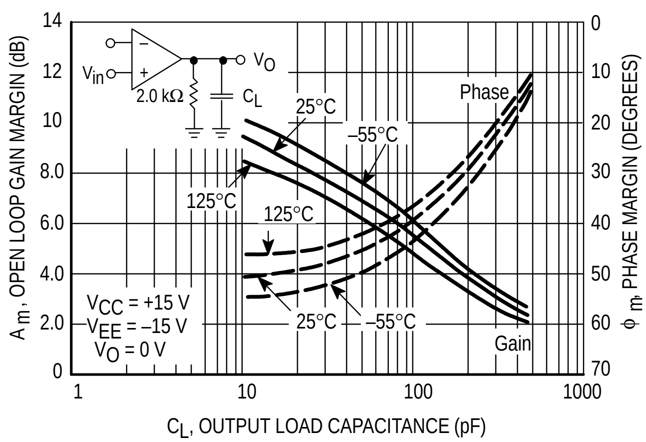


Figure 26. Overshoot versus Output Load Capacitance

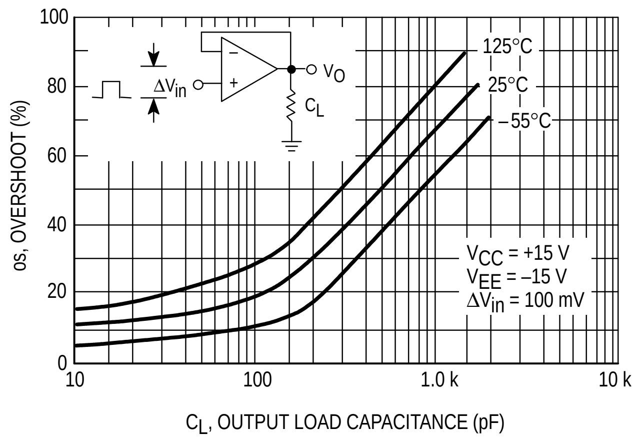


Figure 27. Input Referred Noise Voltage and Current versus Frequency

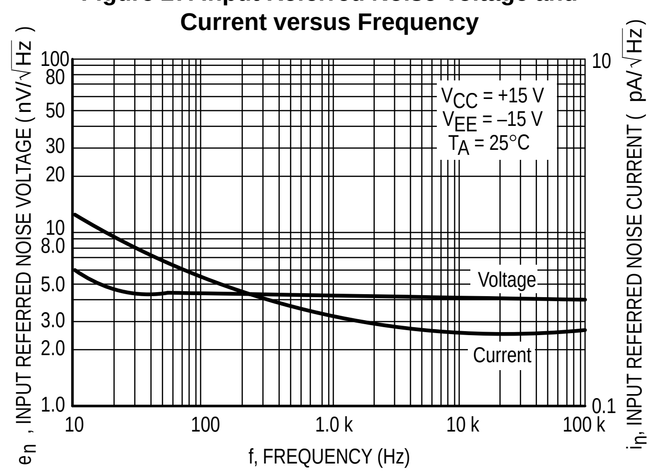


Figure 28. Total Input Referred Noise Voltage versus Source Resistance

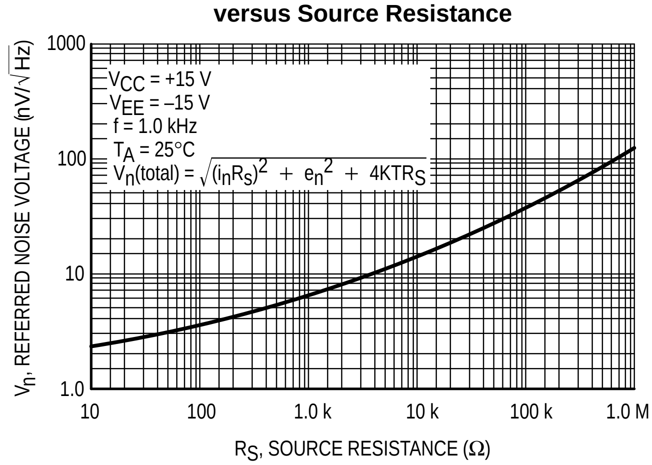


Figure 29. Phase Margin and Gain Margin versus Differential Source Resistance

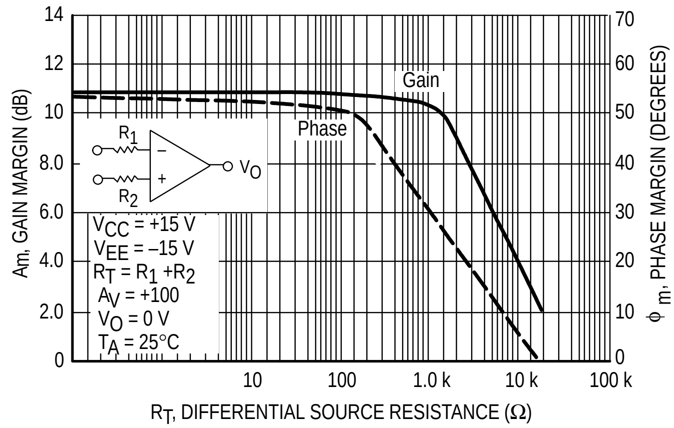


Figure 30. Inverting Amplifier Slew Rate

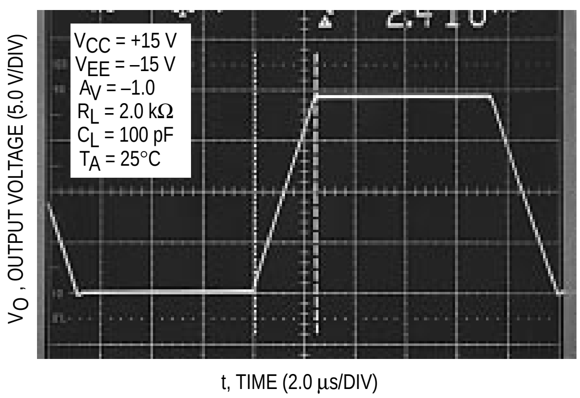


Figure 31. Noninverting Amplifier Slew Rate

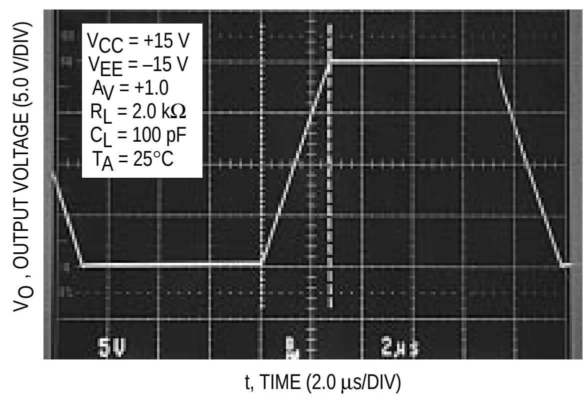


Figure 32. Noninverting Amplifier Overshoot

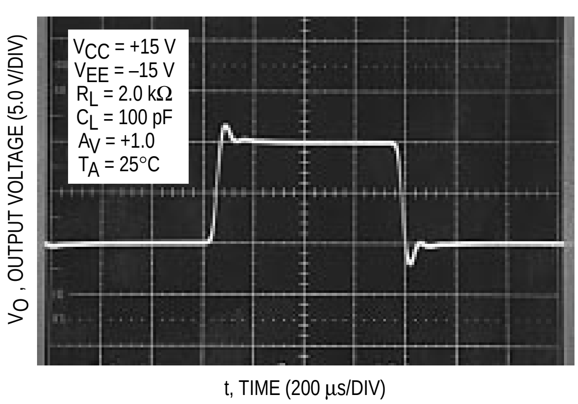


Figure 33. Low Frequency Noise Voltage versus Time

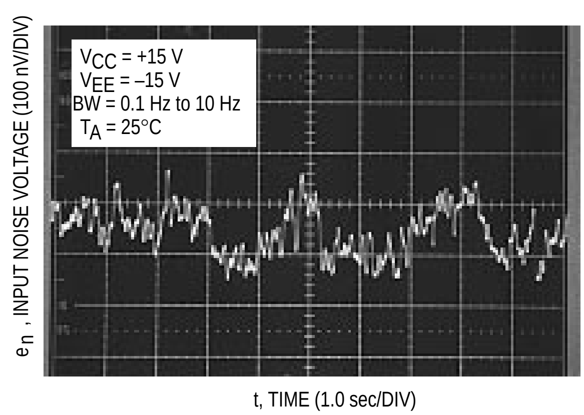
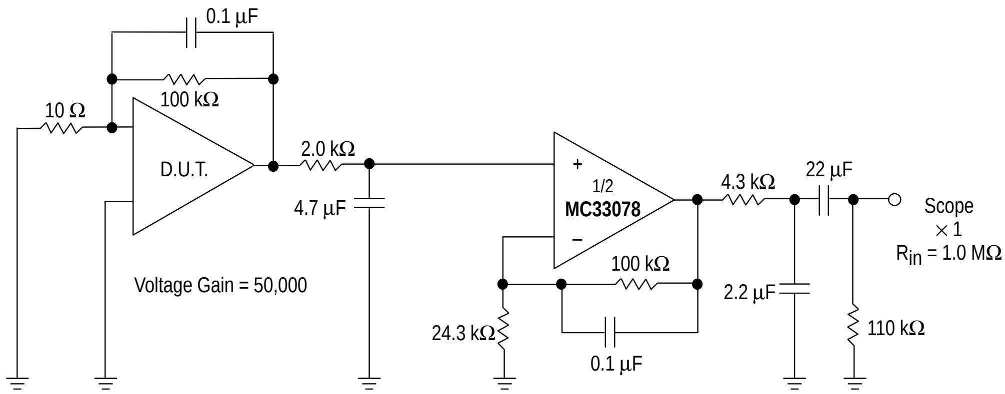


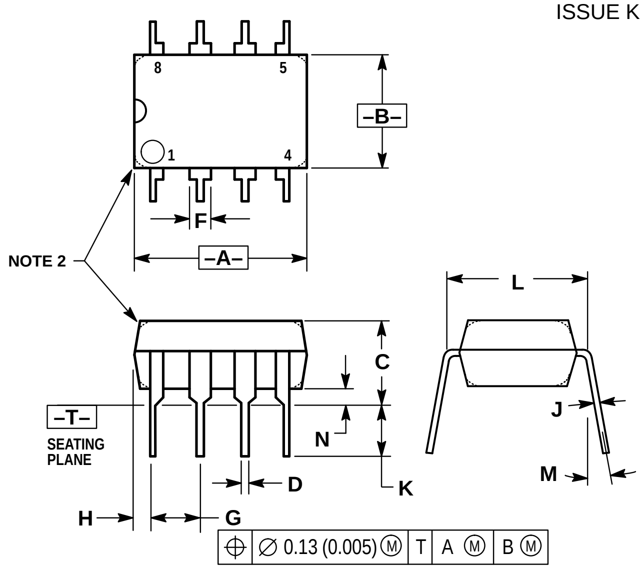
Figure 34. Voltage Noise Test Circuit
(0.1 Hz to 10 Hz$_{p-p}$)



Note: All capacitors are non–polarized.

OUTLINE DIMENSIONS

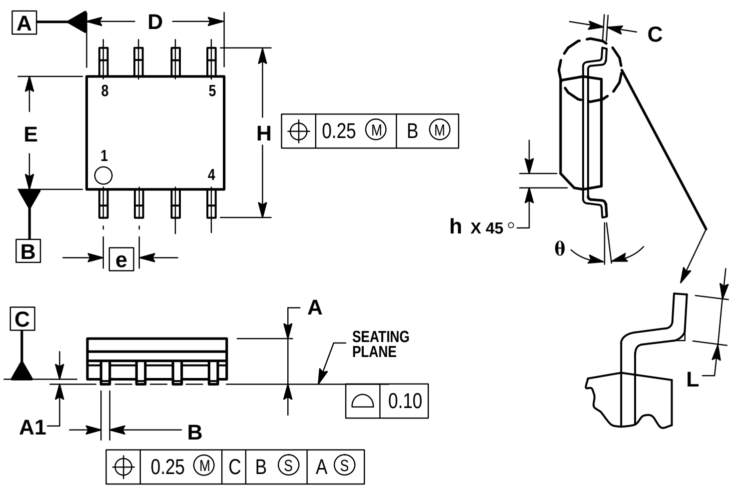
P SUFFIX
PLASTIC PACKAGE
CASE 626–05
ISSUE K



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.

DIM	MILLIMETERS		INCHES	
	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

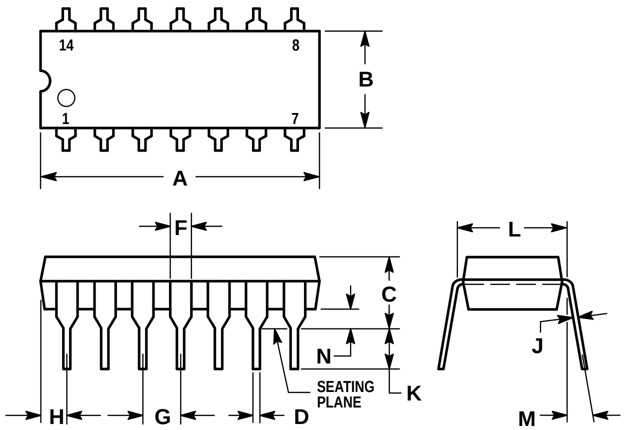


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF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

DIM	MILLIMETERS	
	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°

OUTLINE DIMENSIONS

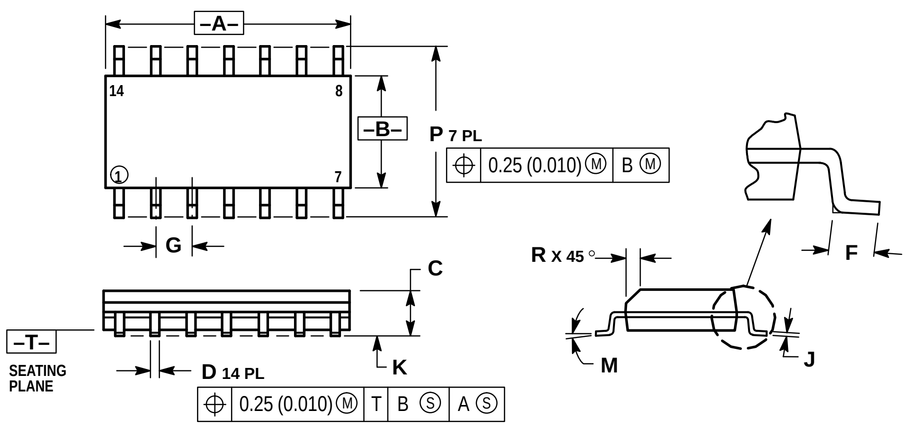
P SUFFIX
PLASTIC PACKAGE
CASE 646–06
ISSUE L



NOTES:
1. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.715	0.770	18.16	19.56
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
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
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	0.039	0.39	1.01

D SUFFIX
PLASTIC PACKAGE
CASE 751A–03
(SO–14)
ISSUE F



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS 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.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

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