MOTOROLA

TL062
TL064

Low Power JFET Input Operational Amplifiers

These JFET input operational amplifiers are designed for low power applications. They feature high input impedance, low input bias current and low input offset current. Advanced design techniques allow for higher slew rates, gain bandwidth products and output swing.

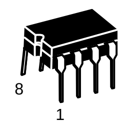
The commercial and vehicular devices are available in Plastic dual in–line and SOIC packages.

- Low Supply Current: 200 µA/Amplifier
- Low Input Bias Current: 5.0 pA
- High Gain Bandwidth: 2.0 MHz
- High Slew Rate: 6.0 V/µs
- High Input Impedance: 10^{12} Ω
- Large Output Voltage Swing: ±14 V
- Output Short Circuit Protection

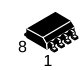
LOW POWER JFET INPUT OPERATIONAL AMPLIFIERS

SEMICONDUCTOR TECHNICAL DATA

DUAL

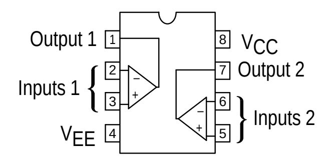


P SUFFIX
PLASTIC PACKAGE
CASE 626



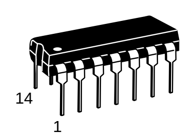
D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO–8)

PIN CONNECTIONS

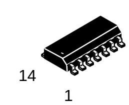


(Top View)

QUAD

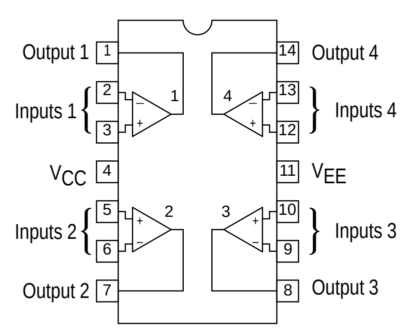


N SUFFIX
PLASTIC PACKAGE
CASE 646



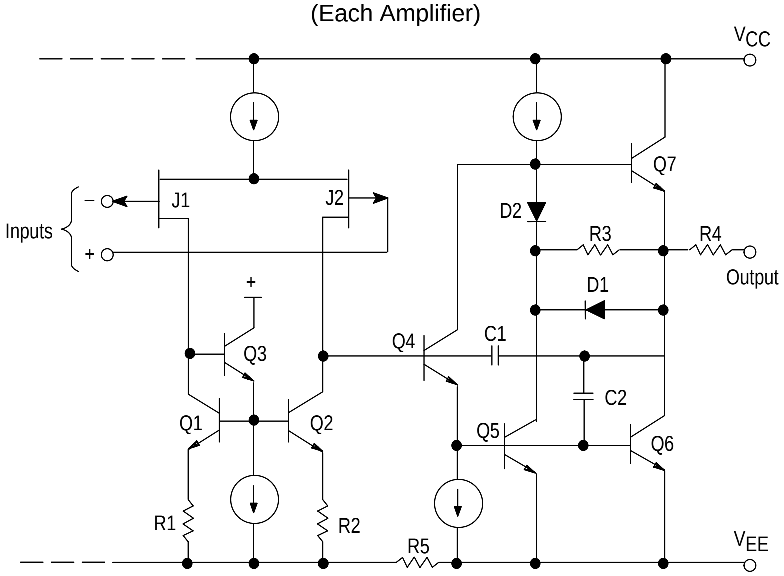
D SUFFIX
PLASTIC PACKAGE
CASE 751A
(SO–14)

PIN CONNECTIONS



(Top View)

Representative Schematic Diagram
(Each Amplifier)



ORDERING INFORMATION

Op Amp Function	Device	Operating Temperature Range	Package
Dual	TL062CD, ACD TL062CP, ACP	T_A = 0° to +70°C	SO–8 Plastic DIP
	TL062VD TL062VP	T_A = –40° to +85°C	SO–8 Plastic DIP
Quad	TL064CD, ACD TL064CN, ACN	T_A = 0° to +70°C	SO–14 Plastic DIP
	TL064VD TL064VN	T_A = –40° to +85°C	SO–14 Plastic DIP

MAXIMUM RATINGS

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

NOTES: 1. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.
2. The magnitude of the input voltage must never exceed the magnitude of the supply or 15 V, whichever is less.
3. Power dissipation must be considered to ensure maximum junction temperature (T_J) is not exceeded. (See Figure 1.)

ELECTRICAL CHARACTERISTICS (V_{CC} = +15 V, V_{EE} = –15 V, T_A = 0° to +70°C, unless otherwise noted.)

Characteristics	Symbol	TL062AC TL064AC			TL062C TL064C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (R_S = 50 Ω, V_O = 0V)	V_{IO}							mV
T_A = 25°C		—	3.0	6.0	—	3.0	15	
T_A = 0° to +70°C		—	—	7.5	—	—	20	
Average Temperature Coefficient for Offset Voltage (R_S = 50 Ω, V_O = 0 V)	$\Delta V_{IO}/\Delta T$	—	10	—	—	10	—	µV/°C
Input Offset Current (V_{CM} = 0 V, V_O = 0 V)	I_{IO}							
T_A = 25°C		—	0.5	100	—	0.5	200	pA
T_A = 0° to +70°C		—	—	2.0	—	—	2.0	nA
Input Bias Current (V_{CM} = 0 V, V_O = 0 V)	I_{IB}							
T_A = 25°C		—	3.0	200	—	3.0	200	pA
T_A = 0° to +70°C		—	—	2.0	—	—	10	nA
Input Common Mode Voltage Range T_A = 25°C	V_{ICR}	— –11.5	+14.5 –12.0	+11.5 —	— –11	+14.5 –12.0	+11 —	V
Large Signal Voltage Gain (R_L = 10 kΩ, V_O = ±10 V)	A_{VOL}							V/mV
T_A = 25°C		4.0	58	—	3.0	58	—	
T_A = 0° to +70°C		4.0	—	—	3.0	—	—	
Output Voltage Swing (R_L = 10 kΩ, V_{ID} = 1.0 V)								V
T_A = 25°C	V_O+ V_O-	+10 —	+14 –14	— –10	+10 —	+14 –14	— –10	
T_A = 0° to +70°C	V_O+ V_O-	+10 —	— —	— –10	+10 —	— —	— –10	
Common Mode Rejection (R_S = 50 Ω, V_{CM} = V_{ICR} min, V_O = 0 V, T_A = 25°C)	CMR	80	84	—	70	84	—	dB
Power Supply Rejection (R_S = 50 Ω, V_{CM} = 0 V, V_O = 0, T_A = 25°C)	PSR	80	86	—	70	86	—	dB
Power Supply Current (each amplifier) (No Load, V_O = 0 V, T_A = 25°C)	I_D	—	200	250	—	200	250	µA
Total Power Dissipation (each amplifier) (No Load, V_O = 0 V, T_A = 25°C)	P_D	—	6.0	7.5	—	6.0	7.5	mW

DC ELECTRICAL CHARACTERISTICS (V_{CC} = +15 V, V_{EE} = –15 V, T_A = T_{low} to T_{high} [Note 4], unless otherwise noted.)

Characteristics	Symbol	TL062V Min	TL062V Typ	TL062V Max	TL064V Min	TL064V Typ	TL064V Max	Unit
Input Offset Voltage (R_S = 50 Ω, V_O = 0V) T_A = 25°C T_A = T_{low} to T_{high}	V_{IO}	 — —	 3.0 —	 6.0 9.0	 — —	 3.0 —	 9.0 15	mV
Average Temperature Coefficient for Offset Voltage (R_S = 50 Ω, V_O = 0 V)	$\Delta V_{IO}/\Delta T$	 —	 10	 —	 —	 10	 —	µV/°C
Input Offset Current (V_{CM} = 0 V, V_O = 0 V) T_A = 25°C T_A = T_{low} to T_{high}	I_{IO}	 — —	 5.0 —	 100 20	 — —	 5.0 —	 100 20	 pA nA
Input Bias Current (V_{CM} = 0 V, V_O = 0 V) T_A = 25°C T_A = T_{low} to T_{high}	I_{IB}	 — —	 30 —	 200 50	 — —	 30 —	 200 50	 pA nA
Input Common Mode Voltage Range (T_A = 25°C)	V_{ICR}	— –11.5	+14.5 –12.0	+11.5 —	— –11.5	+14.5 –12.0	+11.5 —	V
Large Signal Voltage Gain (R_L = 10 kΩ, V_O = ±10 V) T_A = 25°C T_A = T_{low} to T_{high}	A_{VOL}	 4.0 4.0	 58 —	 — —	 4.0 4.0	 58 —	 — —	V/mV
Output Voltage Swing (R_L = 10 kΩ, V_{ID} = 1.0 V) T_A = 25°C T_A = T_{low} to T_{high}	 V_O+ V_O– V_O+ V_O–	 +10 — +10 —	 +14 –14 — —	 — –10 — –10	 +10 — +10 —	 +14 –14 — —	 — –10 — –10	V
Common Mode Rejection (R_S = 50 Ω, V_{CM} = V_{ICR} min, V_O = 0, T_A = 25°C)	CMR	 80	 84	 —	 80	 84	 —	dB
Power Supply Rejection (R_S = 50 Ω, V_{CM} = 0 V, V_O = 0, T_A = 25°C)	PSR	 80	 86	 —	 80	 86	 —	dB
Power Supply Current (each amplifier) (No Load, V_O = 0 V, T_A = 25°C)	I_D	 —	 200	 250	 —	 200	 250	µA
Total Power Dissipation (each amplifier) (No Load, V_O = 0 V, T_A = 25°C)	P_D	 —	 6.0	 7.5	 —	 6.0	 7.5	mW

NOTE: 4. T_{low} = –40°C T_{high} = +85°C for TL062,4V

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 = 10 kΩ, C_L = 100 pF, A_V = +1.0)	SR	2.0	6.0	—	V/µs
Rise Time (V_{in} = 20 mV, R_L = 10 kΩ, C_L = 100 pF, A_V = +1.0)	t_r	—	0.1	—	µs
Overshoot (V_{in} = 20 mV, R_L = 10 kΩ, C_L = 100 pF, A_V = +1.0)	OS	—	10	—	%
Settling Time (V_{CC} = +15 V, V_{EE} = –15 V, A_V = –1.0, To within 10 mV R_L = 10 kΩ, V_O = 0 V to +10 V step) To within 1.0 mV	t_S	 — —	 1.6 2.2	 — —	µs
Gain Bandwidth Product (f = 200 kHz)	GBW	—	2.0	—	MHz
Equivalent Input Noise (R_S = 100 Ω, f = 1.0 kHz)	e_n	—	47	—	$nV/\sqrt{Hz}$
Input Resistance	R_i	—	10^{12}	—	W
Channel Separation (f = 10 kHz)	CS	—	120	—	dB

Figure 1. Maximum Power Dissipation versus Temperature for Package Variations

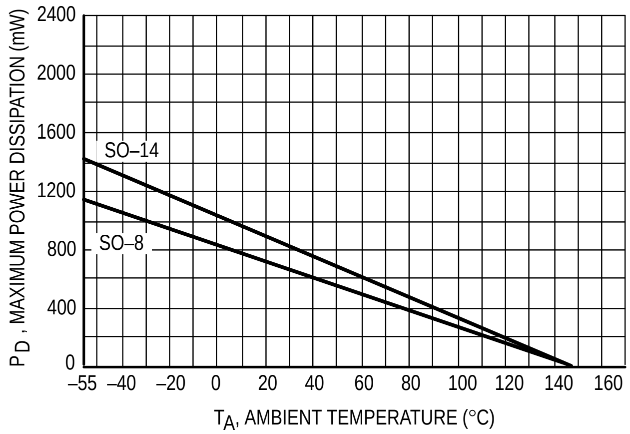


Figure 2. Output Voltage Swing versus Supply Voltage

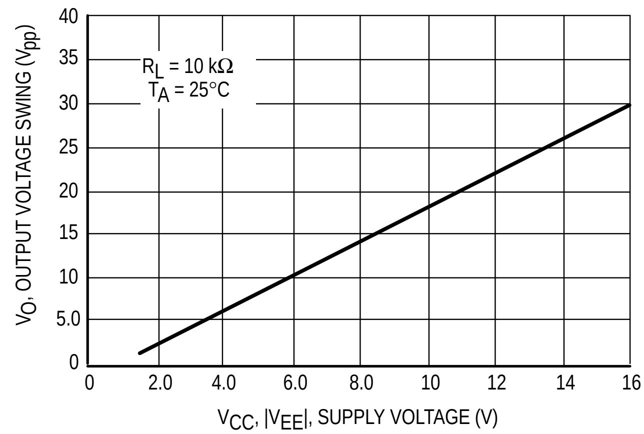


Figure 3. Output Voltage Swing versus Temperature

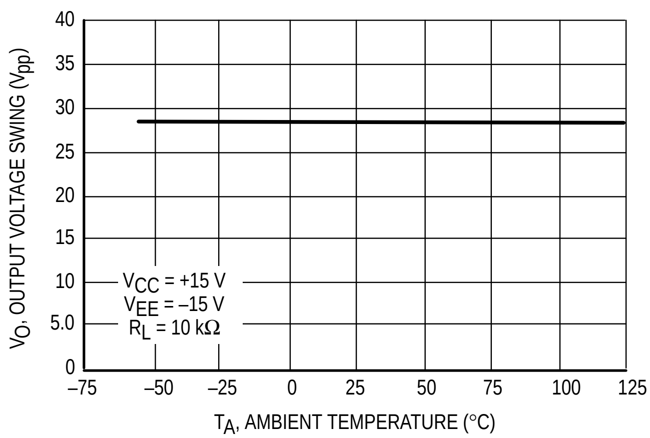


Figure 4. Output Voltage Swing versus Load Resistance

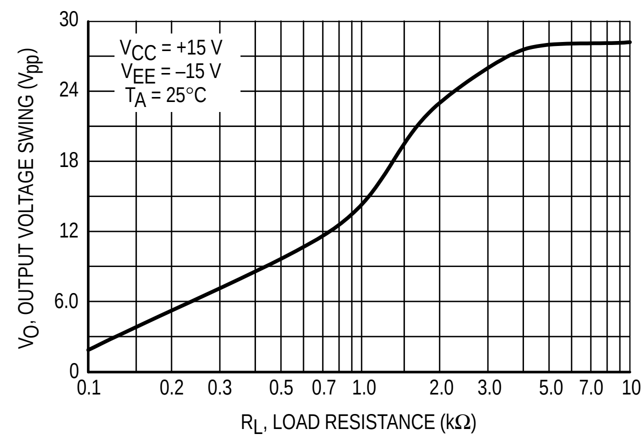


Figure 5. Output Voltage Swing versus Frequency

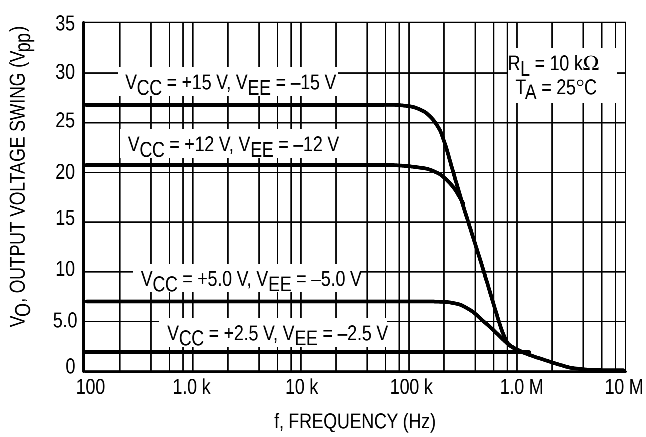


Figure 6. Large Signal Voltage Gain versus Temperature

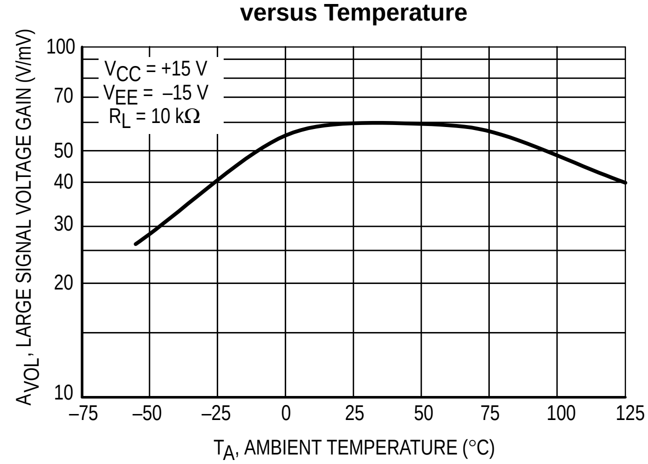


Figure 7. Open Loop Voltage Gain and Phase versus Frequency

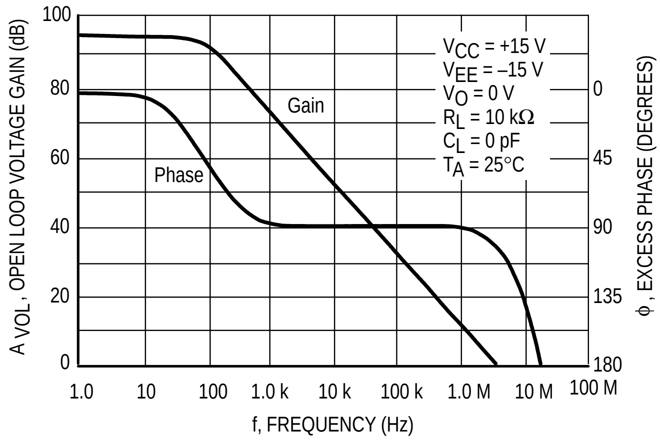


Figure 8. Supply Current per Amplifier versus Supply Voltage

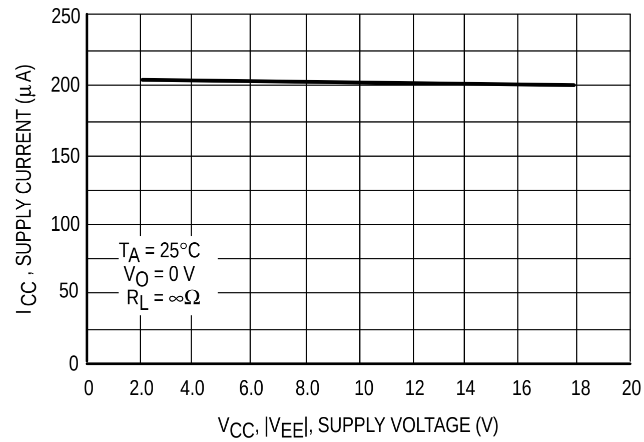


Figure 9. Supply Current per Amplifier versus Temperature

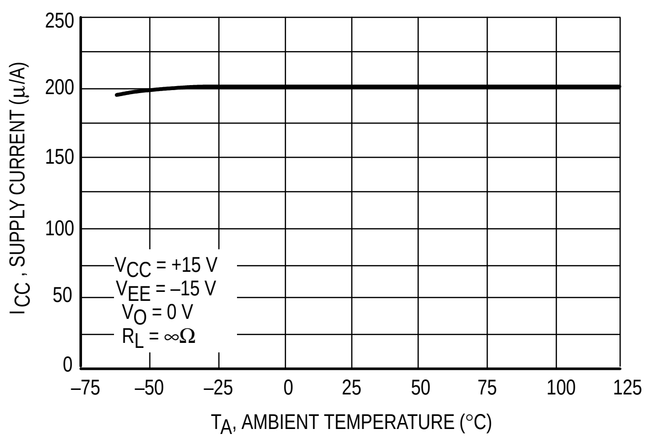


Figure 10. Total Power Dissipation versus Temperature

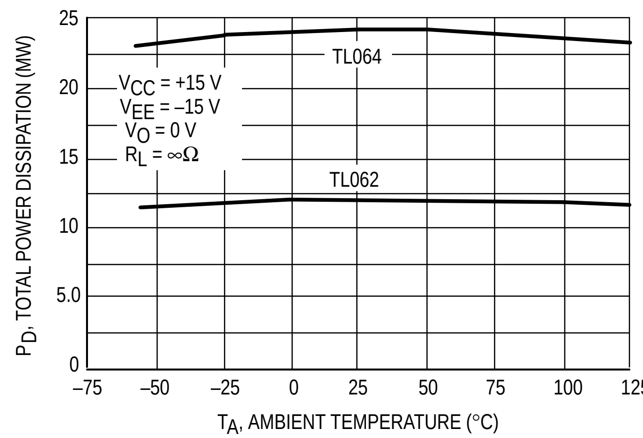


Figure 11. Common Mode Rejection versus Temperature

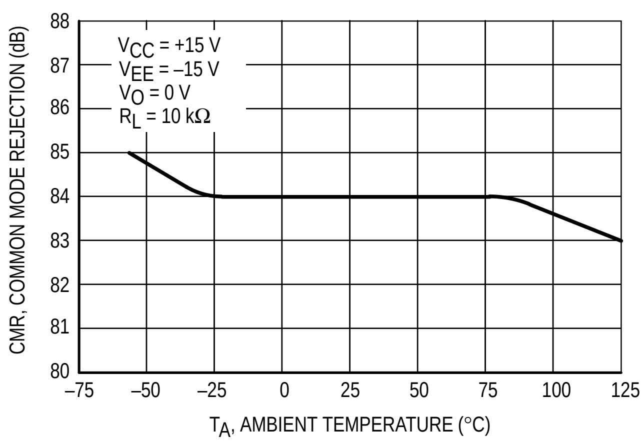


Figure 12. Common Mode Rejection versus Frequency

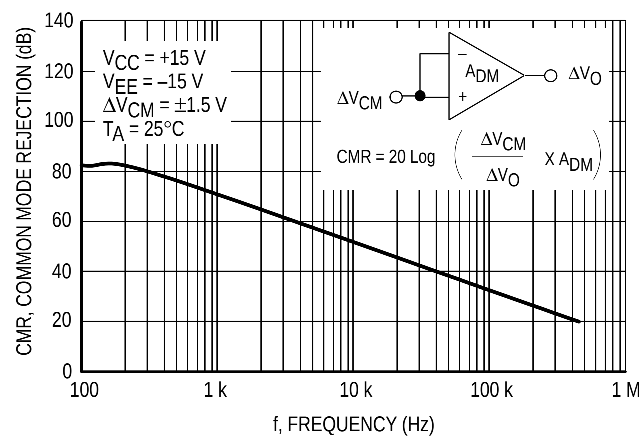


Figure 13. Power Supply Rejection versus Frequency

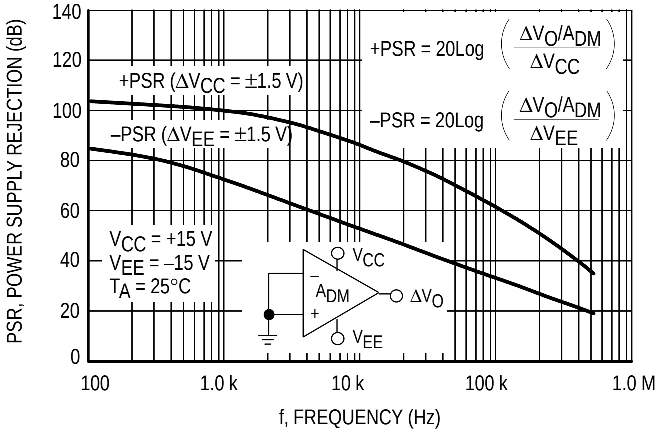


Figure 14. Normalized Gain Bandwidth Product, Slew Rate and Phase Margin versus Temperature

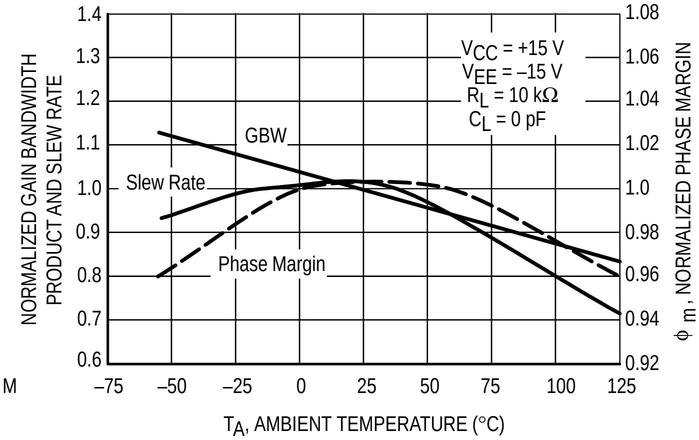


Figure 15. Input Bias Current versus Temperature

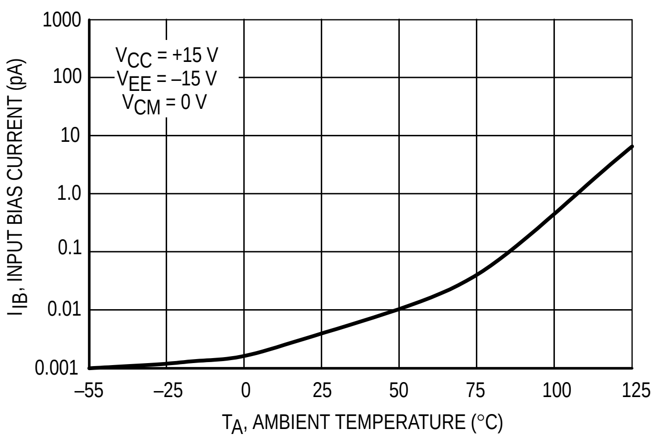


Figure 16. Input Noise Voltage versus Frequency

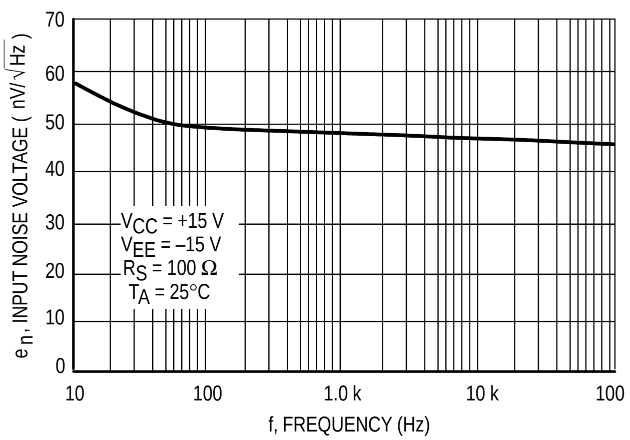


Figure 17. Small Signal Response

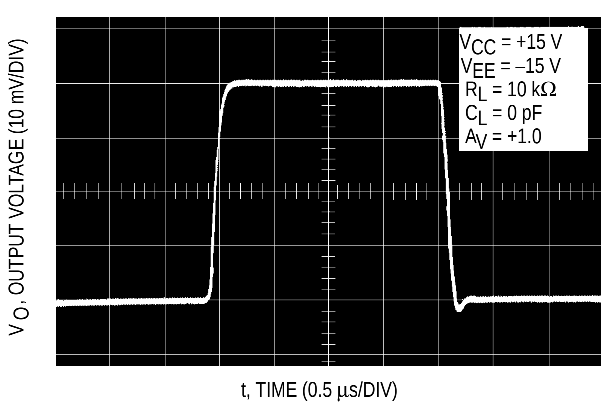


Figure 18. Large Signal Response

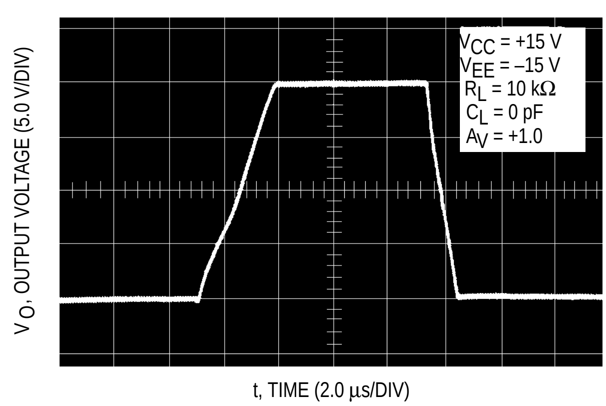


Figure 19. AC Amplifier

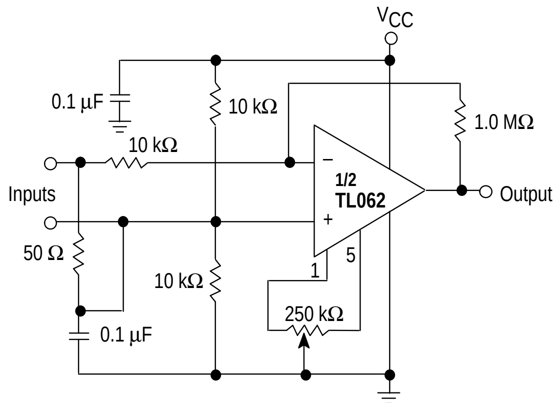


Figure 20. High–Q Notch Filter

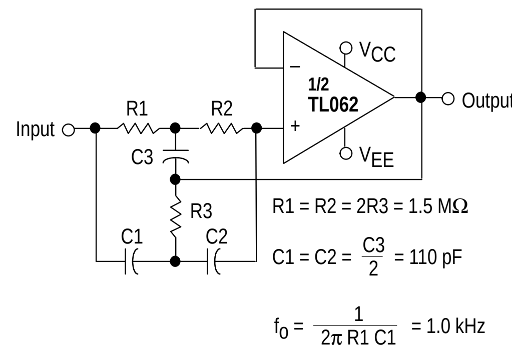


Figure 21. Instrumentation Amplifier

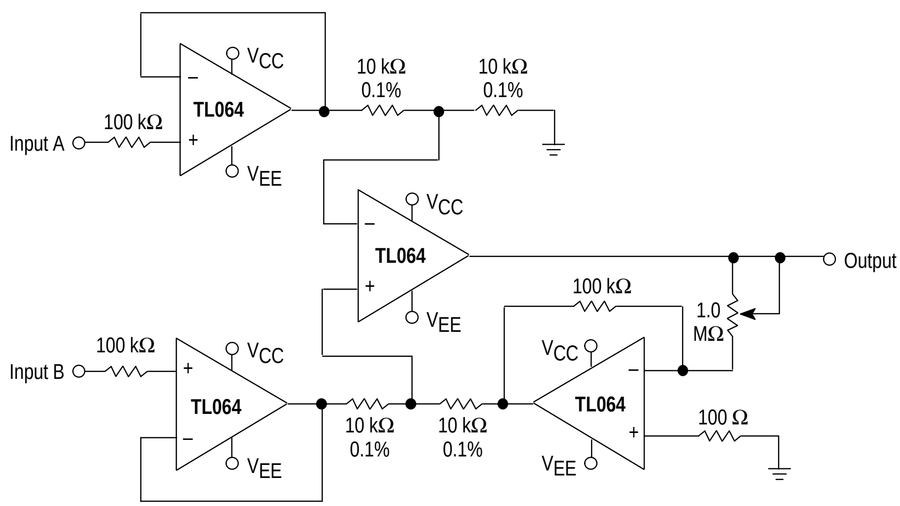


Figure 22. 0.5 Hz Square–Wave Oscillator

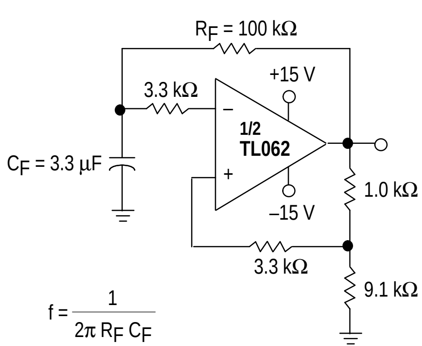
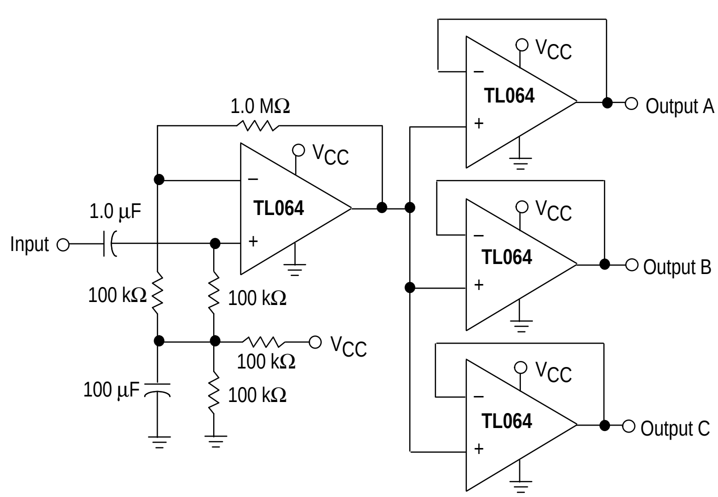
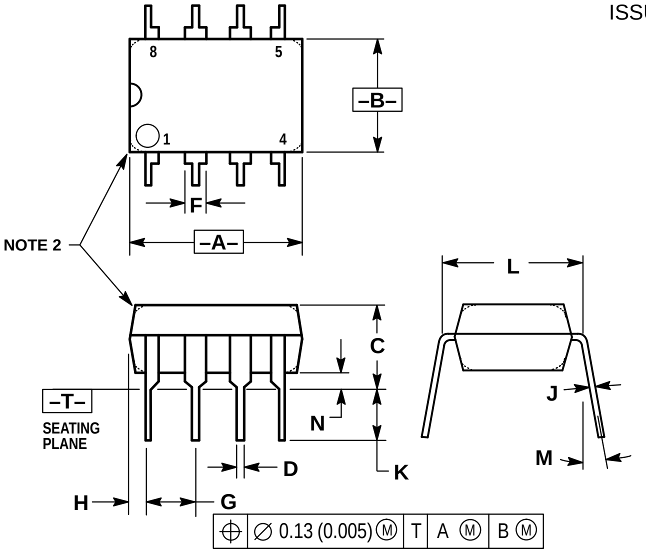


Figure 23. Audio Distribution Amplifier



OUTLINE DIMENSIONS

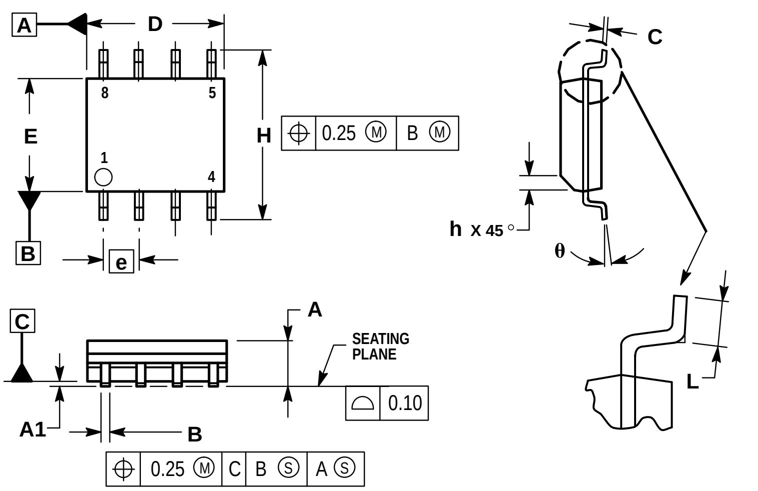
P SUFFIX
PLASTIC PACKAGE
CASE 626–05
ISSUE K



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.

	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

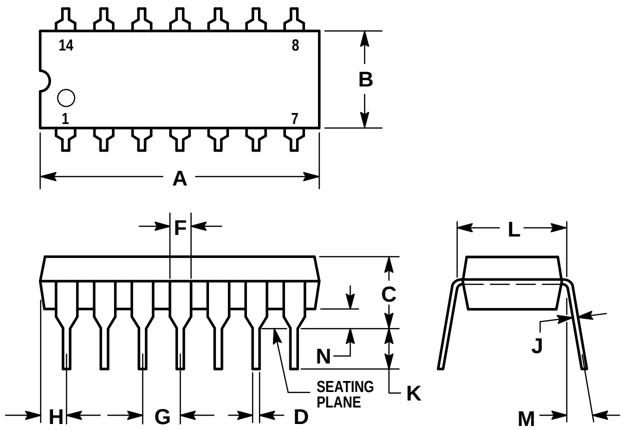


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF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

OUTLINE DIMENSIONS

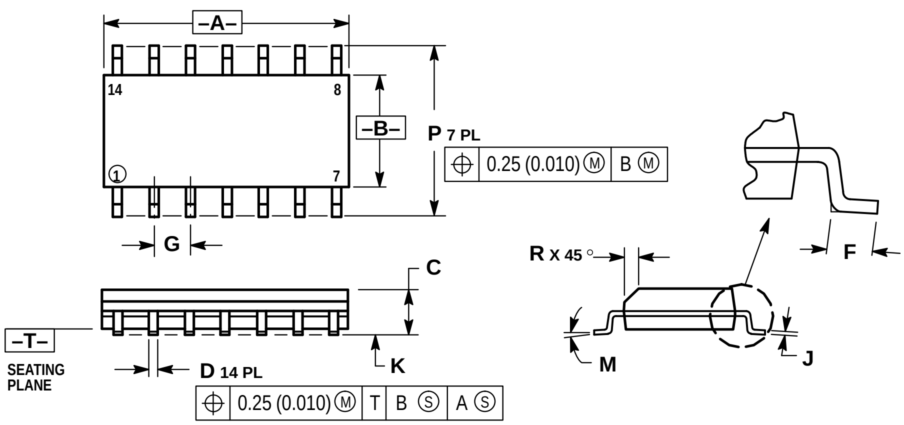
N SUFFIX
PLASTIC PACKAGE
CASE 646–06
ISSUE L



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.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	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.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	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

NOTES

NOTES

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