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MOTOROLA

LM348
LM248

Differential Input Operational Amplifiers

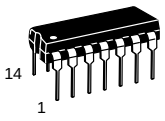
The LM348 series is a true quad MC1741. Integrated on a single monolithic chip are four independent, low power operational amplifiers which have been designed to provide operating characteristics identical to those of the industry standard MC1741, and can be applied with no change in circuit performance. In addition, the total supply current for all four amplifiers is comparable to the supply current of a single MC1741. Other features include input offset currents and input bias currents which are much less than the MC1741 industry standard.

The LM348 can be used in applications where amplifier matching or high packing density is important. Other applications include high impedance buffer amplifiers and active filter amplifiers.

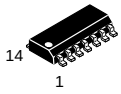
- Each Amplifier is Functionally Equivalent to the MC1741
- Low Input Offset and Input Bias Currents
- Class AB Output Stage Eliminates Crossover Distortion
- Pin Compatible with MC3403 and LM324
- True Differential Inputs
- Internally Frequency Compensated
- Short Circuit Protection
- Low Power Supply Current (0.6 mA/Amplifier)

DIFFERENTIAL INPUT OPERATIONAL AMPLIFIERS

SEMICONDUCTOR TECHNICAL DATA

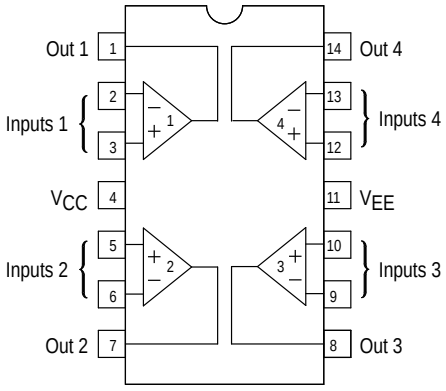


N SUFFIX
PLASTIC PACKAGE
CASE 646



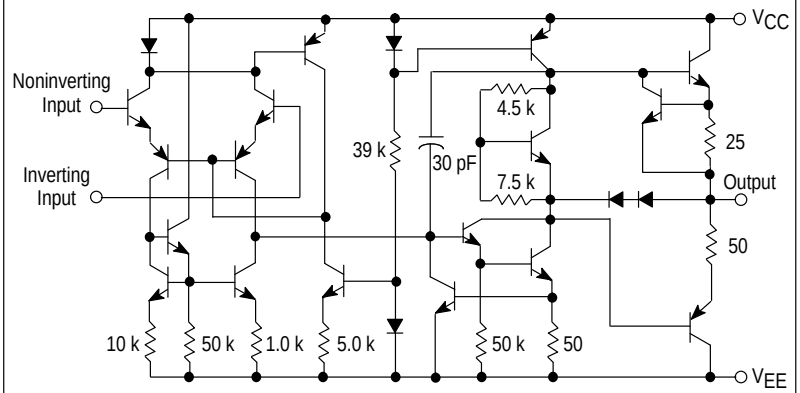
D SUFFIX
PLASTIC PACKAGE
CASE 751A
(SO–14)

PIN CONNECTIONS



(Top View)

Representative Schematic Diagram
(1/4 of Circuit Shown)



ORDERING INFORMATION

Device	Operating Temperature Range	Package
LM248N	T_A = –25° to +85°C	Plastic DIP
LM348D LM348N	T_A = 0° to +70°C	SO–14 Plastic DIP

MAXIMUM RATINGS (T_A = +25°C, unless otherwise noted.)

Rating	Symbol	Value		Unit
Power Supply Voltage	V_{CC} V_{EE}	+18 –18		Vdc
Input Differential Voltage	V_{ID}	±36		V
Input Common Mode Voltage	V_{ICM}	±18		V
Output Short Circuit Duration	t_{SC}	Continuous		
Operating Ambient Temperature Range	T_A	–25 to +85	0 to +70	°C
Storage Temperature Range	T_{stg}	–55 to +125		°C
Junction Temperature	T_J	150		°C

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 ($R_S \le 10$ k)	V_{IO}	–	1.0	6.0	mV
Input Offset Current Input Bias Current	I_{IO} I_{IB}	– –	4.0 30	50 200	nA
Input Resistance	r_i	0.8	2.5	–	MΩ
Common Mode Input Voltage Range	V_{ICR}	±12	–	–	V
Large Signal Voltage Gain ($R_L \ge 2.0$ k, V_O = ±10 V)	A_{VOL}	25	160	–	V/mV
Channel Separation (f = 1.0 Hz to 20 kHz)	–	–	–120	–	dB
Common Mode Rejection ($R_S \le 10$ k) Supply Voltage Rejection ($R_S \le 10$ k)	CMR PSR	70 77	90 96	– –	dB
Output Voltage Swing ($R_L \ge 10$ k) ($R_L \ge 2$ k)	V_O	 ±12 ±10	 ±13 ±12	 – –	V
Output Short Circuit Current	I_{SC}	–	25	–	mA
Supply Current (All Amplifiers)	I_D	–	2.4	4.5	mA
Small Signal Bandwidth (A_V = 1)	BW	–	1.0	–	MHz
Phase Margin (A_V = 1)	ϕm	–	60	–	Degrees
Slew Rate (A_V = 1)	SR	–	0.5	–	V/μs

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

Characteristic	Symbol	Min	Typ	Max	Unit
Input Offset Voltage ($R_S \le 10$ kΩ)	V_{IO}	–	–	7.5	mV
Input Offset Current LM248 LM348 Input Bias Current LM248 LM348	I_{IO} I_{IB} 	 – – – –	 – – – –	 125 100 500 400	nA
Common Mode Input Voltage Range	V_{ICR}	±12	–	–	V
Large Signal Voltage Gain ($R_L \ge 2$ k, V_O = ±10 V)	A_{VOL}	15	–	–	V/mV
Common Mode Rejection ($R_S \le 10$ k) Supply Voltage Rejection ($R_S \le 10$ k)	CMR PSR	70 77	90 96	– –	dB
Output Voltage Swing ($R_L \ge 10$ k) ($R_L \ge 2$ k)	V_O	 ±12 ±10	 ±13 ±12	 – –	V

* T_{high} = 85°C for LM248, and 70°C for LM348. T_{low} = –25°C for LM248, and 0°C for LM348.

NOTE: Any of the amplifier outputs can be shorted to ground indefinitely; however, more than one should not be simultaneously shorted or the maximum junction temperature will be exceeded.

Figure 1. Power Bandwidth (Large Signal Swing versus Frequency)

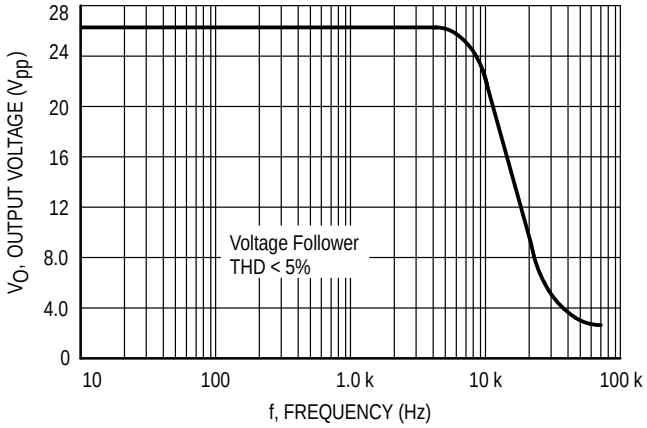


Figure 2. Open Loop Frequency Response

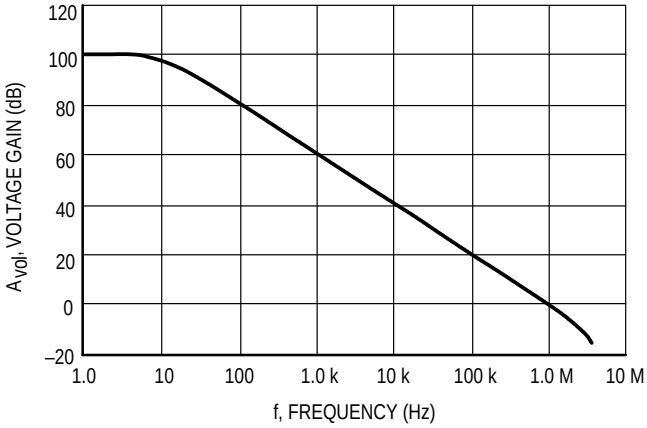


Figure 3. Positive Output Voltage Swing versus Load Resistance

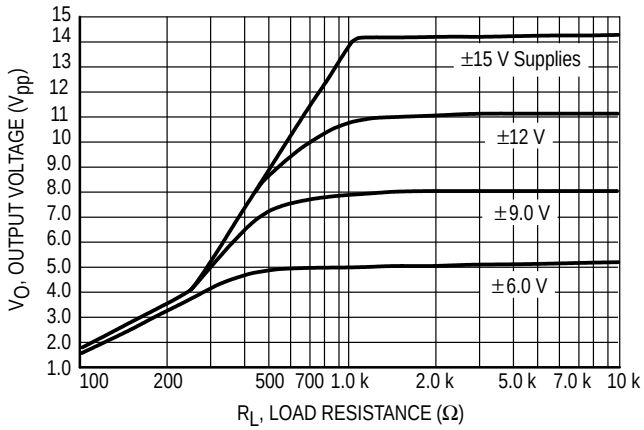


Figure 4. Negative Output Voltage Swing versus Load Resistance

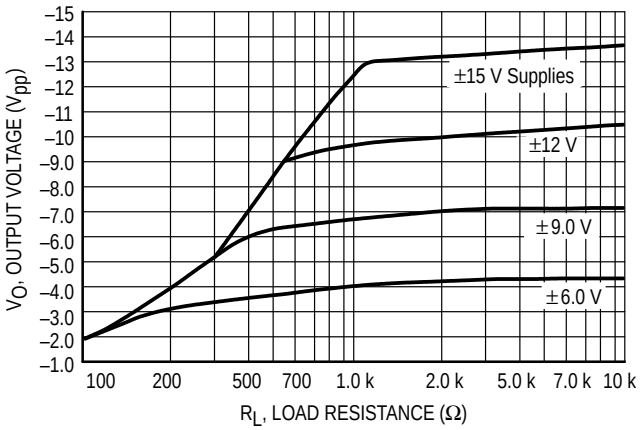


Figure 5. Output Voltage Swing versus Load Resistance (Single Supply Operation)

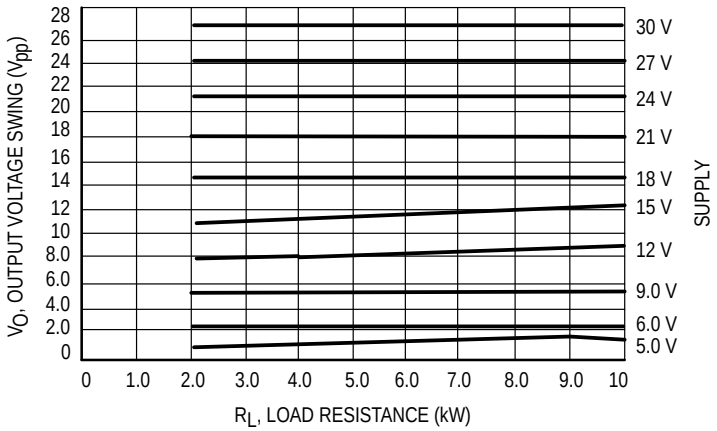


Figure 6. Noninverting Pulse Response

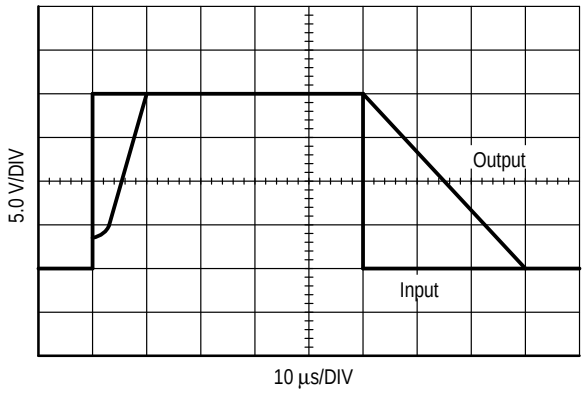
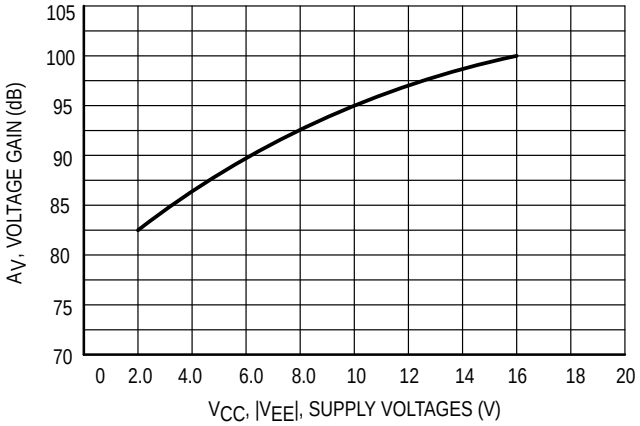
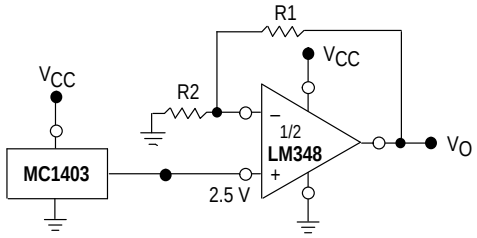


Figure 7. Open Loop Voltage Gain versus Supply Voltage



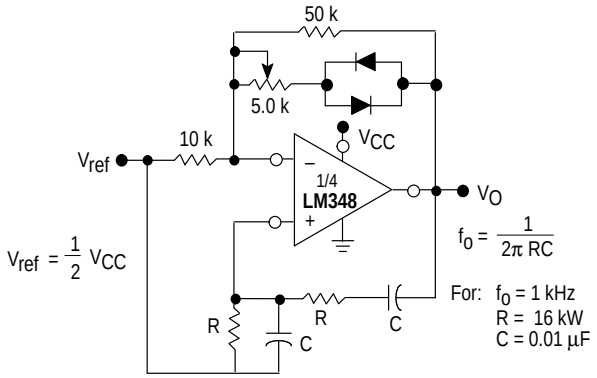
APPLICATIONS INFORMATION

Figure 8. Voltage Reference



$$V_O = 2.5\ V\left(1 + \frac{R1}{R2}\right)$$

Figure 9. Wien Bridge Oscillator

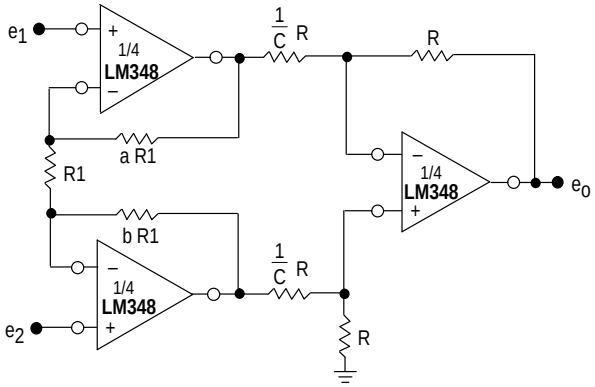


$$V_{ref} = \frac{1}{2} V_{CC}$$

$$f_0 = \frac{1}{2\pi RC}$$

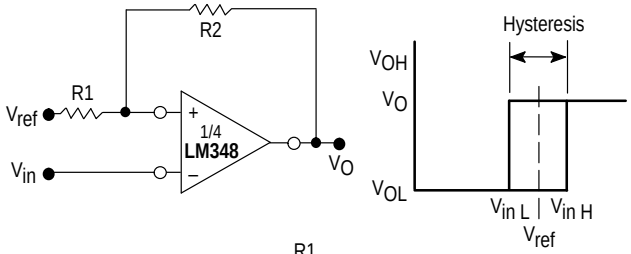
For: f_0 = 1 kHz
R = 16 kW
C = 0.01 µF

Figure 10. High Impedance Differential Amplifier



$$e_0 = C\ (1 + a + b)\ (e_2 - e_1)$$

Figure 11. Comparator with Hysteresis



$$V_{in\,L} = \frac{R1}{R1 + R2}\ (V_{OL} - V_{ref}) + V_{ref}$$

$$V_{in\,H} = \frac{R1}{R1 + R2}\ (V_{OH} - V_{ref}) + V_{ref}$$

$$H = \frac{R1}{R1 + R2}\ (V_{OH} - V_{OL})$$

Figure 12. High Impedance Instrumentation Buffer/Filter

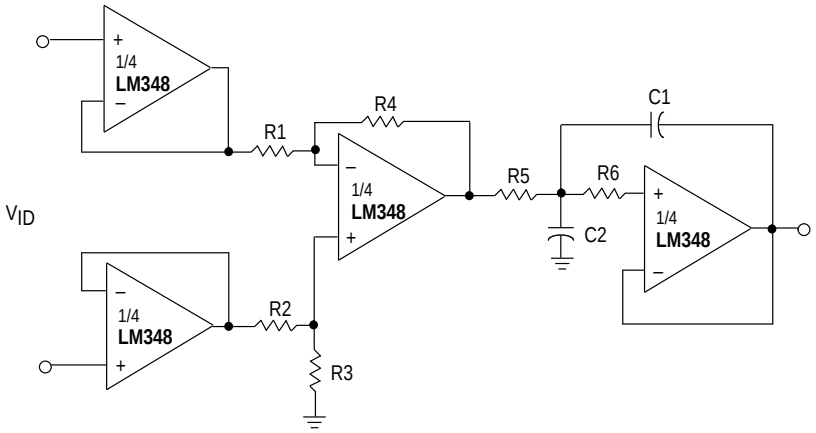


Figure 13. Function Generator

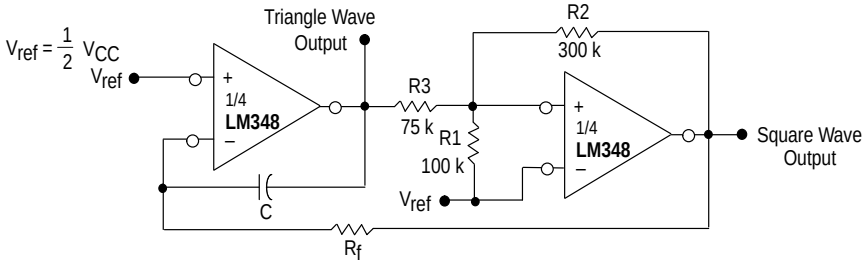


Figure 14. Bi–Quad Filter

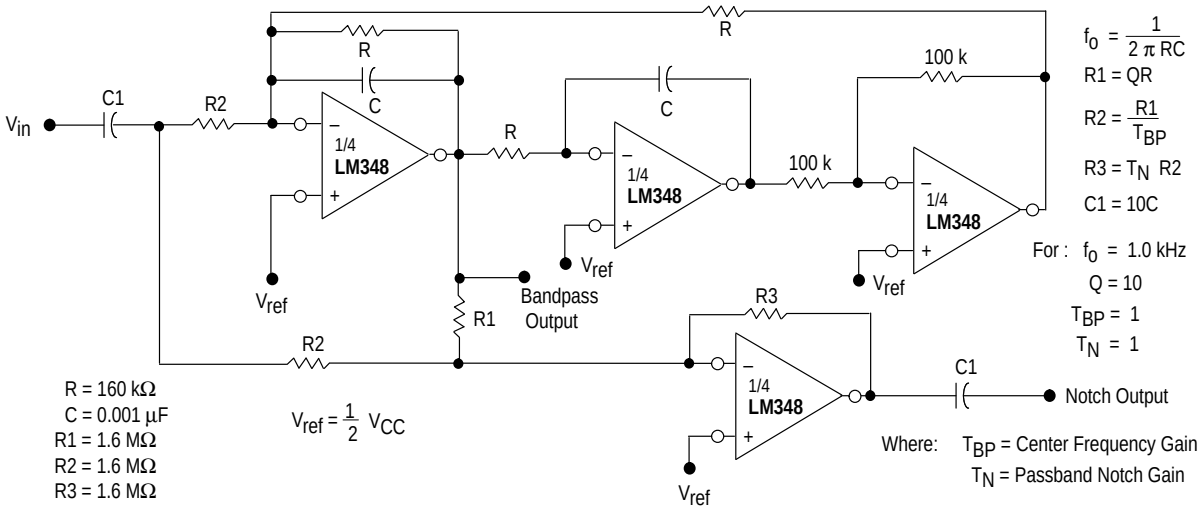
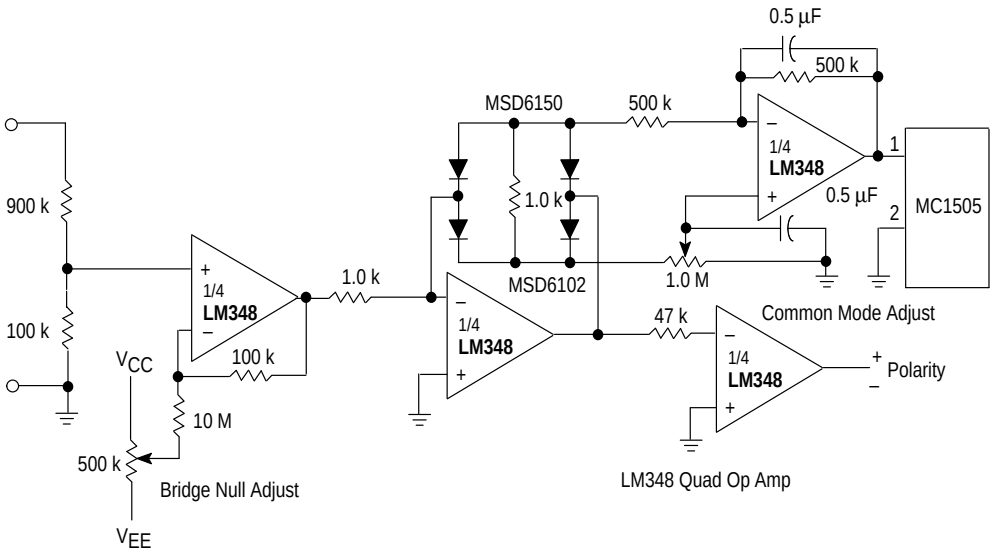
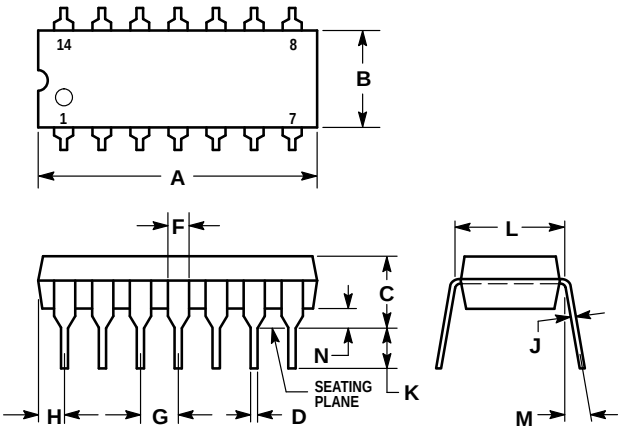


Figure 15. Absolute Value DVM Front End



OUTLINE DIMENSIONS

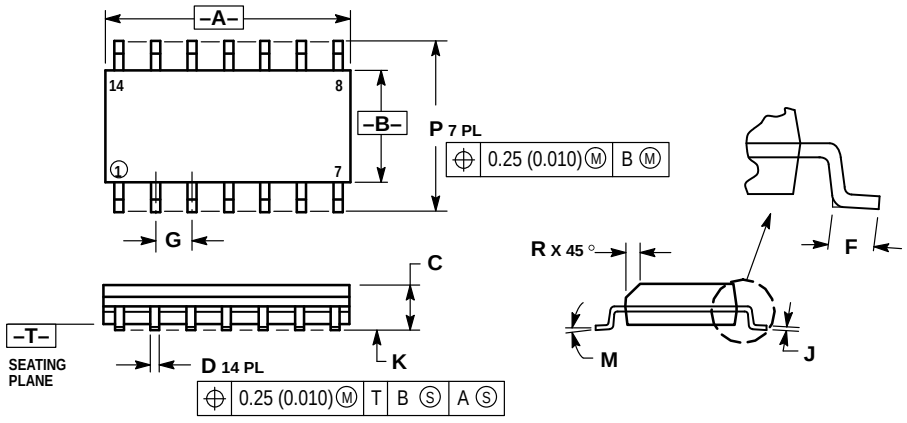
N SUFFIX
PLASTIC PACKAGE
CASE 646–06
ISSUE L



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

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