



# LM348 LM248

## Differential Input Operational Amplifiers

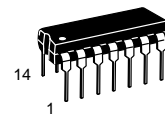
The LM348 series is a true quad MC1741. Integrated on a single monolithic chip are four independent, low power operational amplifiers which have been designed to provide operating characteristics identical to those of the industry standard MC1741, and can be applied with no change in circuit performance. 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.

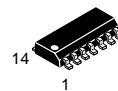
- Each Amplifier is Functionally Equivalent to the MC1741
- Low Input Offset and Input Bias Currents
- Class AB Output Stage Eliminates Crossover Distortion
- Pin Compatible with MC3403 and LM324
- True Differential Inputs
- Internally Frequency Compensated
- Short Circuit Protection
- Low Power Supply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

### DIFFERENTIAL INPUT OPERATIONAL AMPLIFIERS

#### SEMICONDUCTOR TECHNICAL DATA

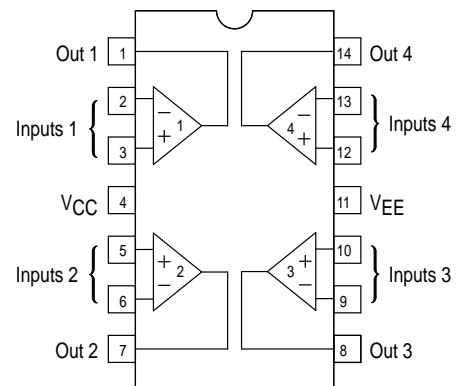


**N SUFFIX**  
PLASTIC PACKAGE  
CASE 646



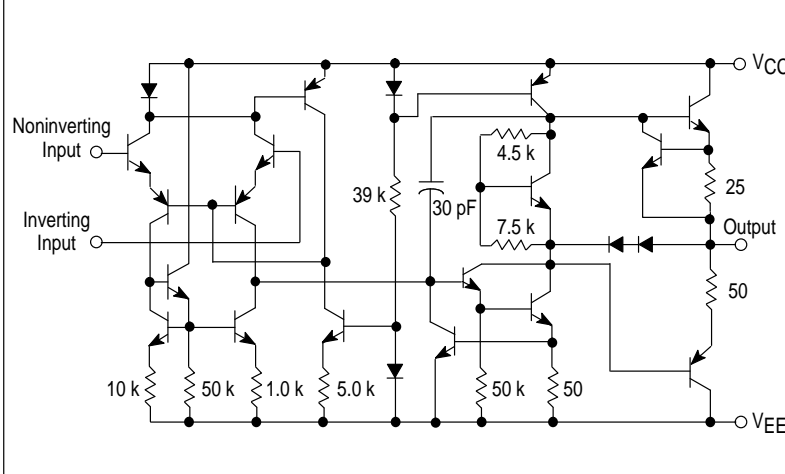
**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751A  
(SO-14)

#### PIN CONNECTIONS



(Top View)

**Representative Schematic Diagram**  
(1/4 of Circuit Shown)



#### ORDERING INFORMATION

Device	Operating Temperature Range	Package
LM248N	$T_A = -25^\circ \text{ to } +85^\circ \text{C}$	Plastic DIP
LM348D LM348N	$T_A = 0^\circ \text{ to } +70^\circ \text{C}$	SO-14 Plastic DIP

# LM348 LM248

## MAXIMUM RATINGS (T<sub>A</sub> = +25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Supply Voltage	V <sub>CC</sub> V <sub>EE</sub>	+18 -18	Vdc
Input Differential Voltage	V <sub>ID</sub>	±36	V
Input Common Mode Voltage	V <sub>ICM</sub>	±18	V
Output Short Circuit Duration	t <sub>SC</sub>	Continuous	
Operating Ambient Temperature Range	T <sub>A</sub>	-25 to +85   0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-55 to +125	°C
Junction Temperature	T <sub>J</sub>	150	°C

## ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = +15 V, V<sub>EE</sub> = -15 V, T<sub>A</sub> = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Input Offset Voltage (R <sub>S</sub> ≤ 10 k)	V <sub>IO</sub>	-	1.0	6.0	mV
Input Offset Current	I <sub>IO</sub>	-	4.0	50	nA
Input Bias Current	I <sub>IB</sub>	-	30	200	nA
Input Resistance	r <sub>i</sub>	0.8	2.5	-	MΩ
Common Mode Input Voltage Range	V <sub>ICR</sub>	±12	-	-	V
Large Signal Voltage Gain (R <sub>L</sub> ≥ 2.0 k, V <sub>O</sub> = ±10 V)	A <sub>VOL</sub>	25	160	-	V/mV
Channel Separation (f = 1.0 Hz to 20 kHz)	-	-	-120	-	dB
Common Mode Rejection (R <sub>S</sub> ≤ 10 k)	CMR	70	90	-	dB
Supply Voltage Rejection (R <sub>S</sub> ≤ 10 k)	PSR	77	96	-	dB
Output Voltage Swing (R <sub>L</sub> ≥ 10 k) (R <sub>L</sub> ≥ 2 k)	V <sub>O</sub>	±12 ±10	±13 ±12	- -	V
Output Short Circuit Current	I <sub>SC</sub>	-	25	-	mA
Supply Current (All Amplifiers)	I <sub>D</sub>	-	2.4	4.5	mA
Small Signal Bandwidth (A <sub>V</sub> = 1)	BW	-	1.0	-	MHz
Phase Margin (A <sub>V</sub> = 1)	φ <sub>m</sub>	-	60	-	Degrees
Slew Rate (A <sub>V</sub> = 1)	SR	-	0.5	-	V/μs

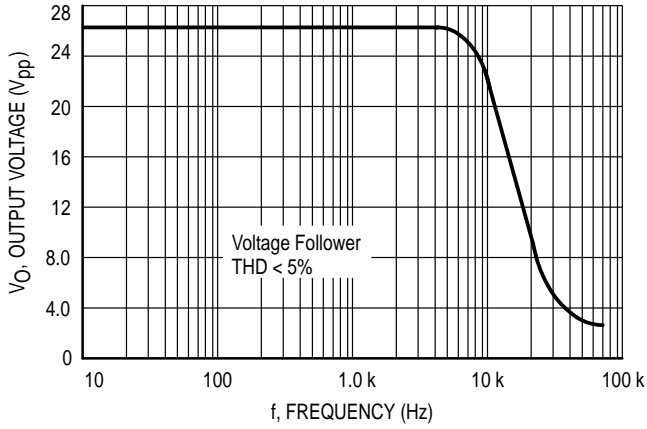
## ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = +15 V, V<sub>EE</sub> = -15 V, T<sub>A</sub> = \*T<sub>high</sub> to T<sub>low</sub>, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Input Offset Voltage (R <sub>S</sub> ≤ 10 kΩ)	V <sub>IO</sub>	-	-	7.5	mV
Input Offset Current	I <sub>IO</sub>	-	-	125	nA
LM248		-	-	100	
LM348		-	-	100	
Input Bias Current	I <sub>IB</sub>	-	-	500	nA
LM248		-	-	400	
LM348		-	-	400	
Common Mode Input Voltage Range	V <sub>ICR</sub>	±12	-	-	V
Large Signal Voltage Gain (R <sub>L</sub> ≥ 2 k, V <sub>O</sub> = ±10 V)	A <sub>VOL</sub>	15	-	-	V/mV
Common Mode Rejection (R <sub>S</sub> ≤ 10 k)	CMR	70	90	-	dB
Supply Voltage Rejection (R <sub>S</sub> ≤ 10 k)	PSR	77	96	-	dB
Output Voltage Swing (R <sub>L</sub> ≥ 10 k) (R <sub>L</sub> ≥ 2 k)	V <sub>O</sub>	±12 ±10	±13 ±12	- -	V

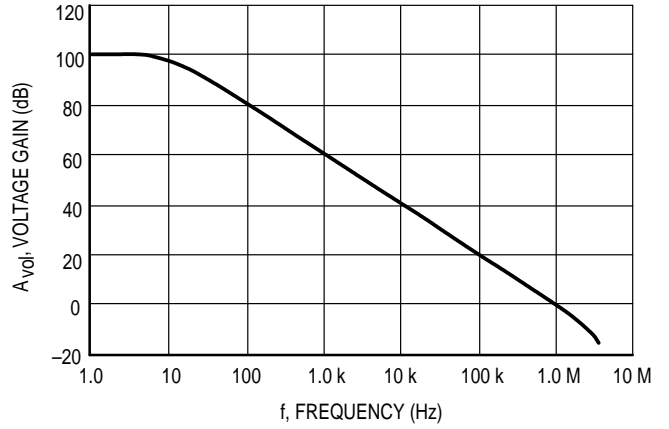
\* T<sub>high</sub> = 85°C for LM248, and 70°C for LM348. T<sub>low</sub> = -25°C for LM248, and 0°C for LM348.

**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.

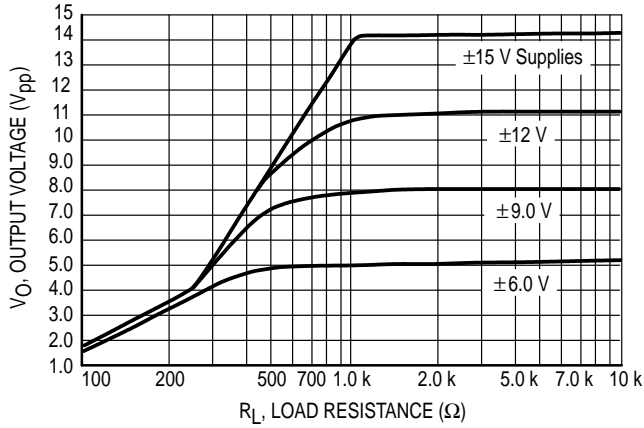
**Figure 1. Power Bandwidth  
(Large Signal Swing versus Frequency)**



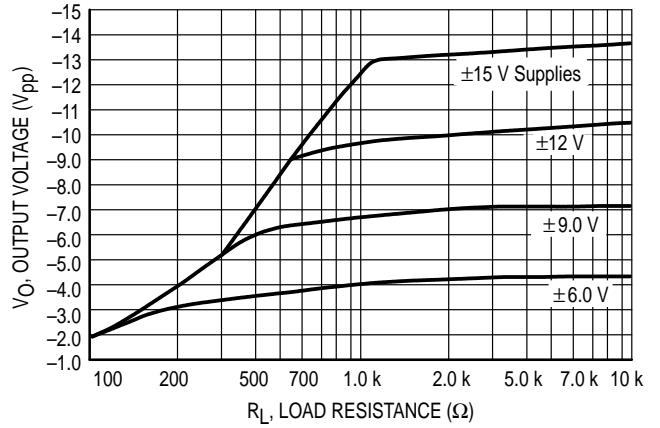
**Figure 2. Open Loop Frequency Response**



**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)**

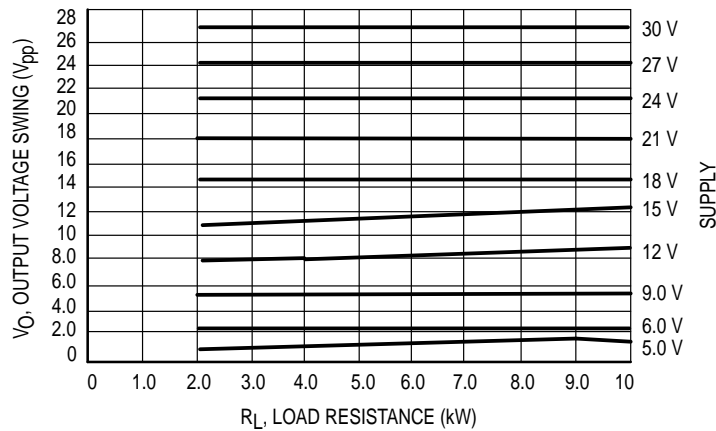


Figure 6. Noninverting Pulse Response

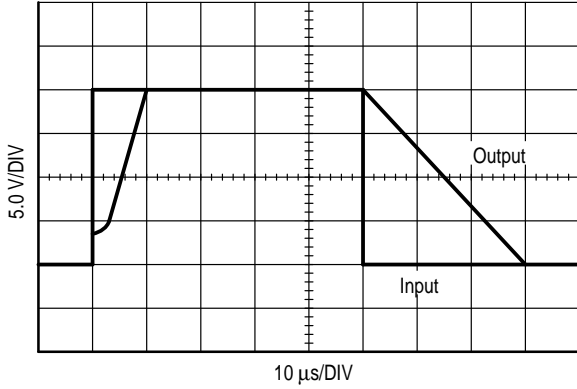
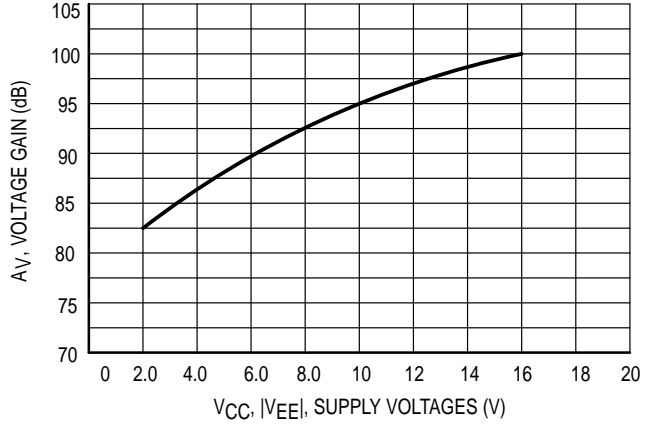


Figure 7. Open Loop Voltage Gain versus Supply Voltage



APPLICATIONS INFORMATION

Figure 8. Voltage Reference

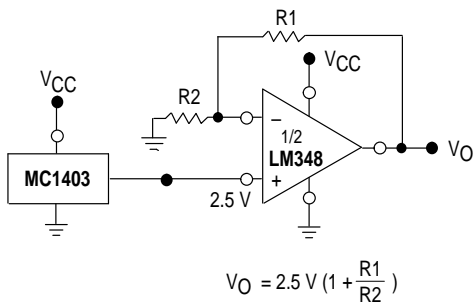


Figure 9. Wien Bridge Oscillator

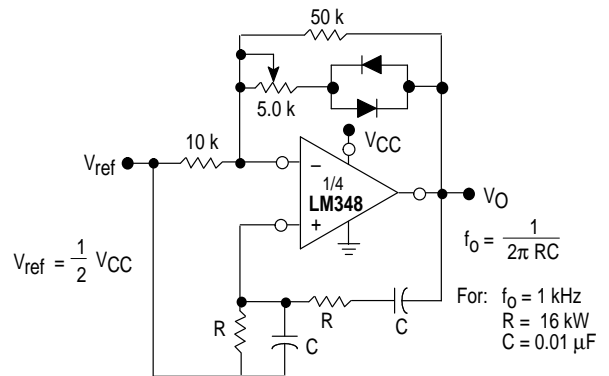


Figure 10. High Impedance Differential Amplifier

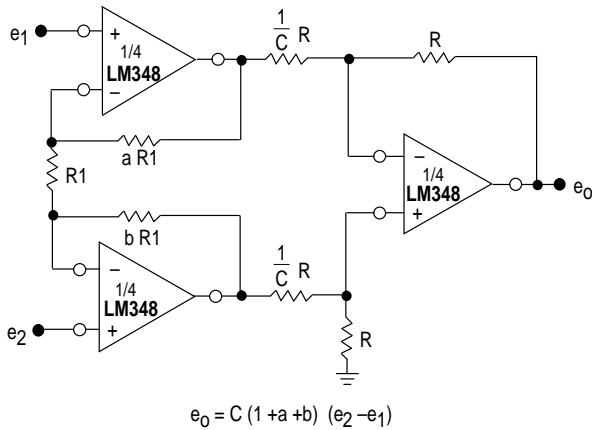
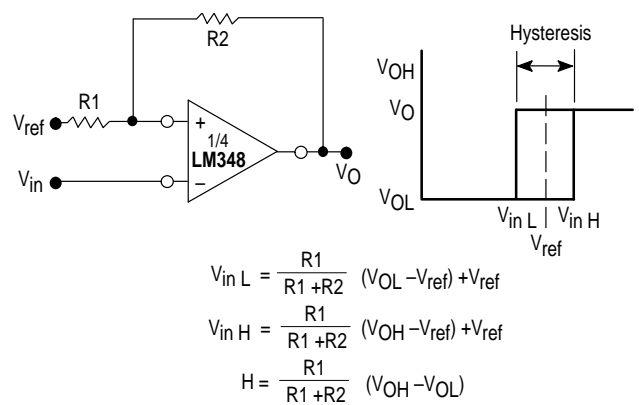


Figure 11. Comparator with Hysteresis



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Figure 12. High Impedance Instrumentation Buffer/Filter

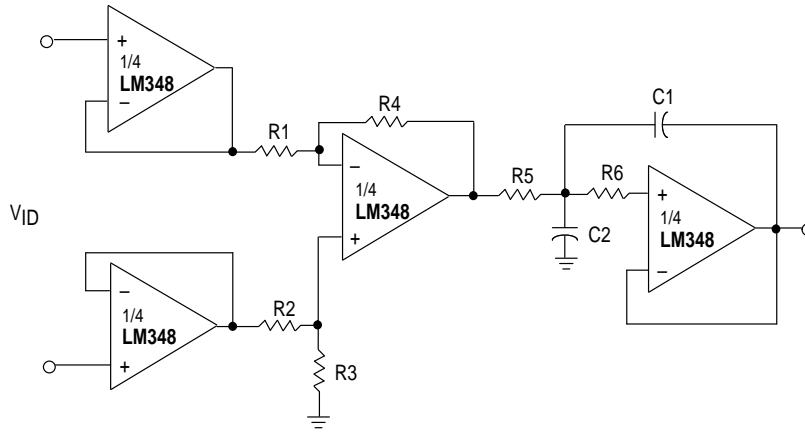


Figure 13. Function Generator

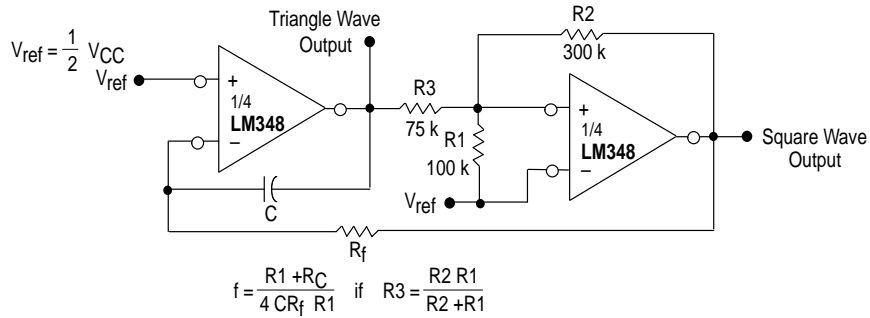
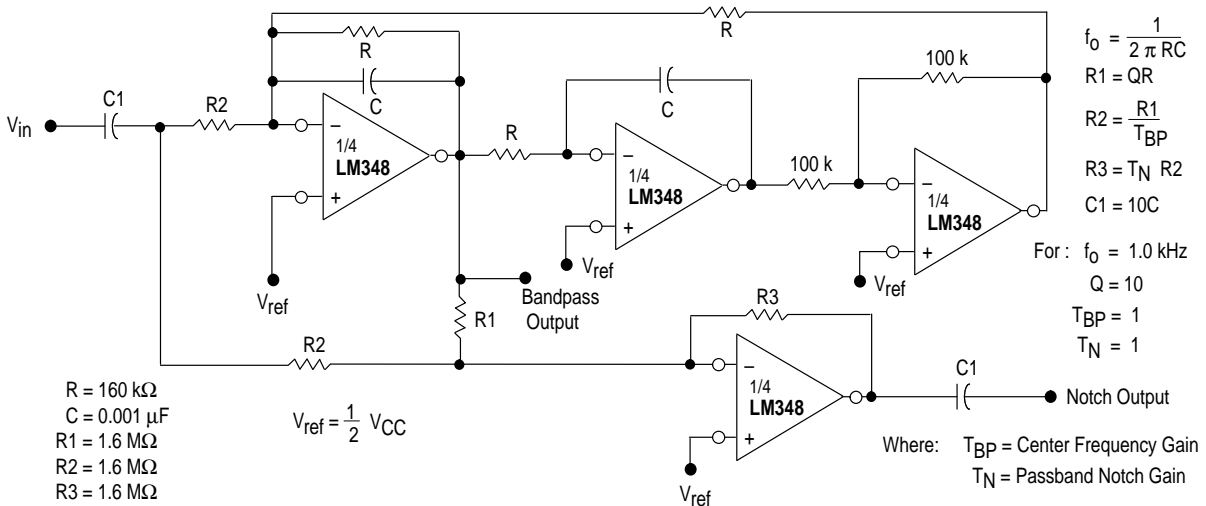
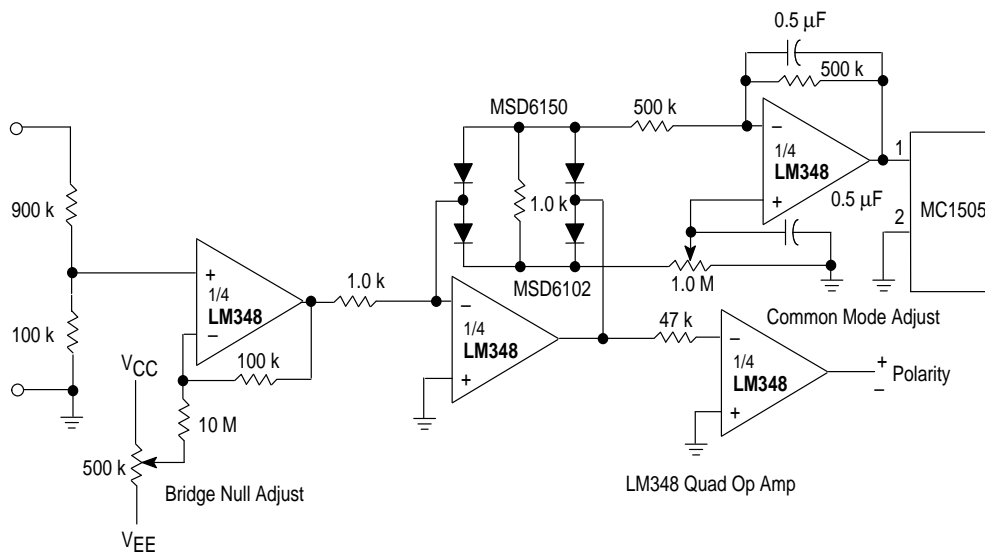


Figure 14. Bi-Quad Filter



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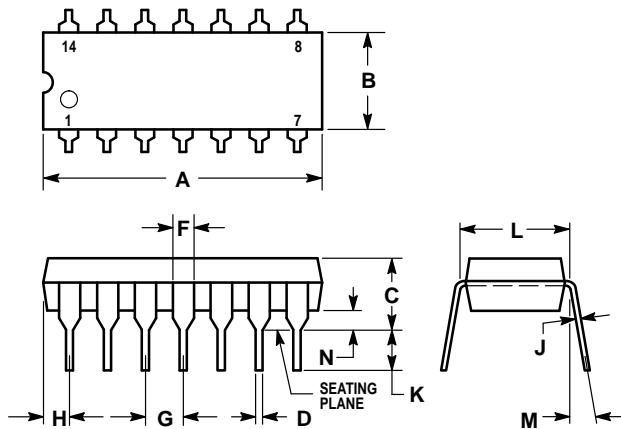
Figure 15. Absolute Value DVM Front End



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## OUTLINE DIMENSIONS

### N SUFFIX PLASTIC PACKAGE CASE 646-06 ISSUE L

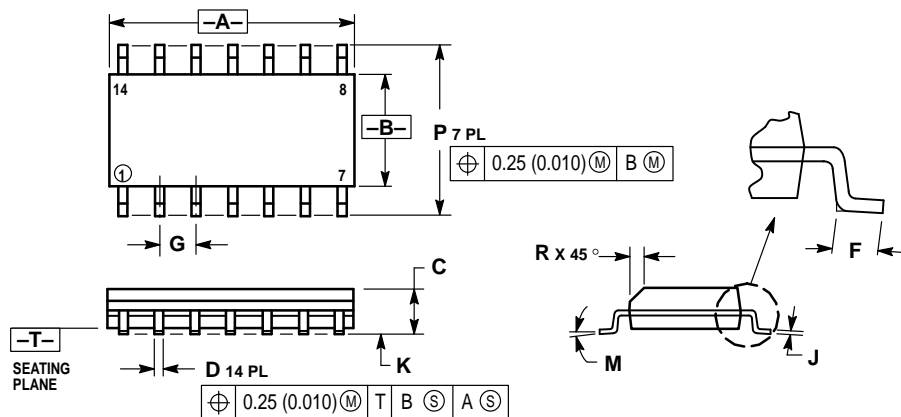


NOTES:

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

DIM	INCHES		MILLIMETERS	
	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:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
- DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
- MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
- 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		INCHES	
	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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