

# JFET Input Operational Amplifiers

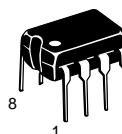
These low cost JFET input operational amplifiers combine two state-of-the-art analog technologies on a single monolithic integrated circuit. Each internally compensated operational amplifier has well matched high voltage JFET input devices for low input offset voltage. The BIFET technology provides wide bandwidths and fast slew rates with low input bias currents, input offset currents, and supply currents.

The ON Semiconductor BIFET family offers single, dual and quad operational amplifiers which are pin-compatible with the industry standard MC1741, MC1458, and the MC3403/LM324 bipolar devices. The MC34001/34002/34004 series are specified from 0° to +70°C.

- Input Offset Voltage Options of 5.0 mV and 10 mV Maximum
- Low Input Bias Current: 40 pA
- Low Input Offset Current: 10 pA
- Wide Gain Bandwidth: 4.0 MHz
- High Slew Rate: 13 V/μs
- Low Supply Current: 1.4 mA per Amplifier
- High Input Impedance: 10<sup>12</sup> Ω
- High Common Mode and Supply Voltage Rejection Ratios: 100 dB
- Industry Standard Pinouts

# MC34001, B MC34002, B MC34004, B

## JFET INPUT OPERATIONAL AMPLIFIERS

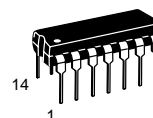
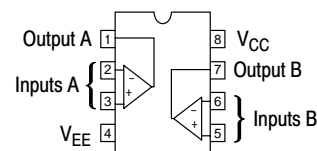
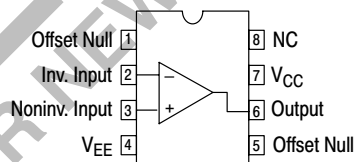


**P SUFFIX**  
PLASTIC PACKAGE  
CASE 626



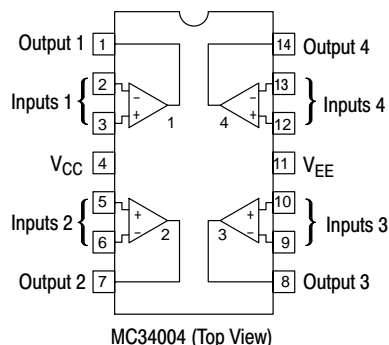
**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751  
(SO-8)

### PIN CONNECTIONS



**P SUFFIX**  
PLASTIC PACKAGE  
CASE 646

### PIN CONNECTIONS



### ORDERING INFORMATION

Op Amp Function	Device	Operating Temperature Range	Package
Single	MC34001BD, D	T <sub>A</sub> = 0° to +70°C	SO-8
	MC34001BP, P		Plastic DIP
Dual	MC34002BD, D	T <sub>A</sub> = 0° to +70°C	SO-8
	MC34002BP, P		Plastic DIP
Quad	MC34004BP, P	T <sub>A</sub> = 0° to +70°C	Plastic DIP

# MC34001, B MC34002, B MC34004, B

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	$V_{CC}, V_{EE}$	$\pm 18$	V
Differential Input Voltage (Note 1)	$V_{ID}$	$\pm 30$	V
Input Voltage Range	$V_{IDR}$	$\pm 16$	V
Open Short Circuit Duration	$t_{SC}$	Continuous	
Operating Ambient Temperature Range	$T_A$	0 to +70	°C
Operating Junction Temperature	$T_J$	150	°C
Storage Temperature Range	$T_{stg}$	-65 to +150	°C

**NOTES:** 1. Unless otherwise specified, the absolute maximum negative input voltage is equal to the negative power supply.

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = +15$ V, $V_{EE} = -15$ V, $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Offset Voltage ( $R_S \leq 10$ k) MC3400XB MC3400X	$V_{IO}$	— —	3.0 5.0	5.0 10	mV
Average Temperature Coefficient of Input Offset Voltage $R_S \leq 10$ k, $T_A = T_{low}$ to $T_{high}$ (Note 2)	$\Delta V_{IO}/\Delta T$	—	10	—	$\mu\text{V}/^\circ\text{C}$
Input Offset Current ( $V_{CM} = 0$ ) (Note 3) MC3400XB MC3400X	$I_{IO}$	— —	25 25	100 100	pA
Input Bias Current ( $V_{CM} = 0$ ) (Note 3) MC3400XB MC3400X	$I_{IB}$	— —	50 50	200 200	pA
Input Resistance	$r_i$	—	$10^{12}$	—	$\Omega$
Common Mode Input Voltage Range	$V_{ICR}$	$\pm 11$ —	+15 -12	— —	V
Large Signal Voltage Gain ( $V_O = \pm 10$ V, $R_L = 2.0$ k) MC3400XB MC3400X	$A_{VOL}$	50 25	150 100	— —	V/mV
Output Voltage Swing ( $R_L \geq 10$ k) ( $R_L \geq 2.0$ k)	$V_O$	$\pm 12$ $\pm 10$	$\pm 14$ $\pm 13$	— —	V
Common Mode Rejection Ratio ( $R_S \leq 10$ k) MC3400XB MC3400X	CMRR	80 70	100 100	— —	dB
Supply Voltage Rejection Ratio ( $R_S \leq 10$ k) (Note 4) MC3400XB MC3400X	PSRR	80 70	100 100	— —	dB
Supply Current (Each Amplifier) MC3400XB MC3400X	$I_D$	— —	1.4 1.4	2.5 2.7	mA
Slew Rate ( $A_V = 1.0$ )	SR	—	13	—	V/ $\mu\text{s}$
Gain-Bandwidth Product	GBW	—	4.0	—	MHz
Equivalent Input Noise Voltage ( $R_S = 100 \Omega$ , $f = 1000$ Hz)	$e_n$	—	25	—	$\text{nV}/\sqrt{\text{Hz}}$
Equivalent Input Noise Current ( $f = 1000$ Hz)	$i_n$	—	0.01	—	$\text{pA}/\sqrt{\text{Hz}}$

**NOTES:** 2.  $T_{low} = 0^\circ\text{C}$  for MC34001/34001B  
MC34002  
MC34004/34004B  
 $T_{high} = +70^\circ\text{C}$  for MC34001/34001B  
MC34002  
MC34004/34004B

3. The input bias currents approximately double for every  $10^\circ\text{C}$  rise in junction temperature,  $T_J$ . Due to limited test time, the input bias currents are correlated to junction temperature. Use of a heatsink is recommended if input bias current is to be kept to a minimum.

4. Supply voltage rejection ratio is measured for both supply magnitudes increasing or decreasing simultaneously, in accordance with common practice.

# MC34001, B MC34002, B MC34004, B

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = +15\text{ V}$ , $V_{EE} = -15\text{ V}$ , $T_A = T_{low}$ to $T_{high}$ [Note 2].)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Offset Voltage ( $R_S \leq 10\text{ k}$ ) MC3400XB MC3400X	$V_{IO}$	— —	— —	7.0 13	mV
Input Offset Current ( $V_{CM} = 0$ ) (Note 3) MC3400XB MC3400X	$I_{IO}$	— —	— —	4.0 4.0	nA
Input Bias Current ( $V_{CM} = 0$ ) (Note 3) MC3400XB MC3400X	$I_{IB}$	— —	— —	8.0 8.0	nA
Common Mode Input Voltage Range	$V_{ICR}$	$\pm 11$	—	—	V
Large Signal ( $V_O = \pm 10\text{ V}$ , $R_L = 2.0\text{ k}$ ) MC3400XB MC3400X	$A_{VOL}$	25 15	— —	— —	V/mV
Output Voltage Swing ( $R \geq 10\text{ k}$ ) ( $R \geq 2.0\text{ k}$ )	$V_O$	$\pm 12$ $\pm 10$	— —	— —	V
Common Mode Rejection Ratio ( $R_S \leq 10\text{ k}$ ) MC3400XB MC3400X	CMRR	80 70	— —	— —	dB
Supply Voltage Rejection Ratio ( $R_S \leq 10\text{ k}$ ) (Note 4) MC3400XB MC3400X	PSRR	80 70	— —	— —	dB
Supply Current (Each Amplifier) MC3400XB MC3400X	$I_D$	— —	— —	2.8 3.0	mA

NOTES: 2.  $T_{low} = 0^\circ\text{C}$  for MC34001/34001B  
           MC34002  
           MC34004/34004B  
            $T_{high} = +70^\circ\text{C}$  for MC34001/34001B  
           MC34002  
           MC34004/34004B

3. The input bias currents approximately double for every  $10^\circ\text{C}$  rise in junction temperature,  $T_J$ . Due to limited test time, the input bias currents are correlated to junction temperature. Use of a heatsink is recommended if input bias current is to be kept to a minimum.

4. Supply voltage rejection ratio is measured for both supply magnitudes increasing or decreasing simultaneously, in accordance with common practice.

Figure 1. Input Bias Current versus Temperature

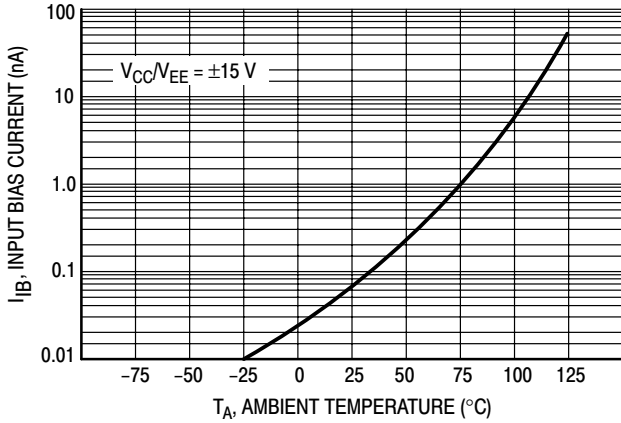


Figure 2. Output Voltage Swing versus Frequency

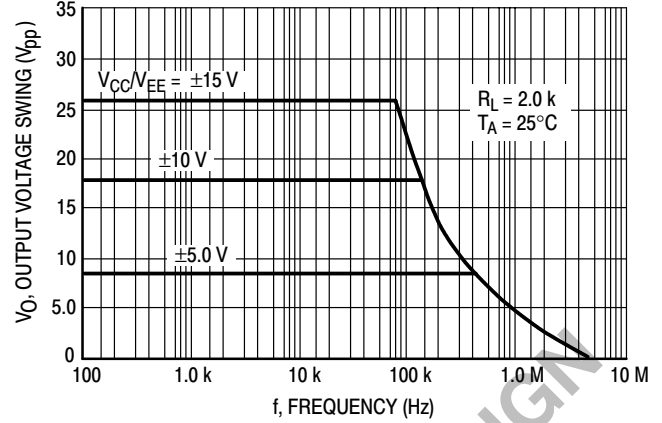


Figure 3. Output Voltage Swing versus Load Resistance

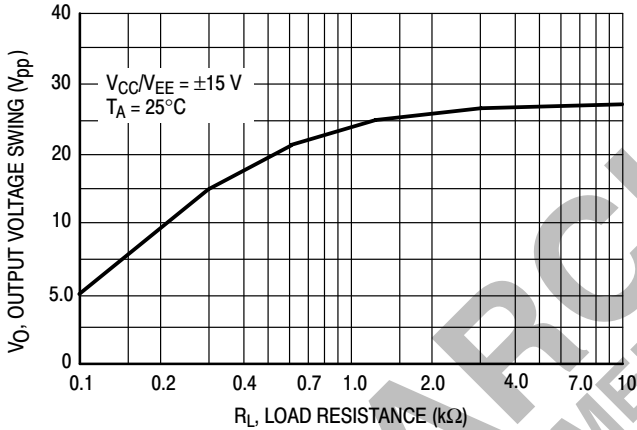


Figure 4. Output Voltage Swing versus Supply Voltage

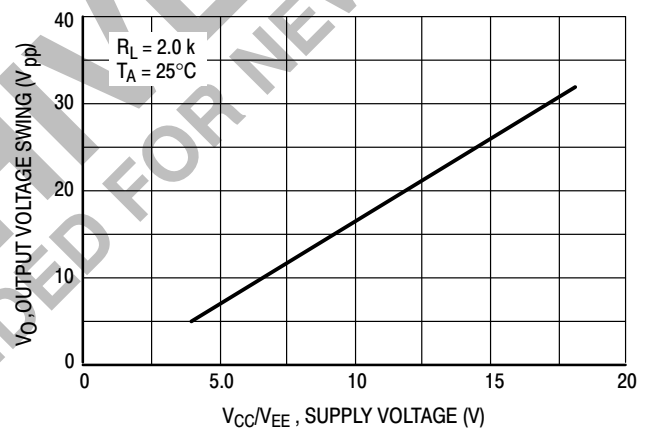


Figure 5. Output Voltage Swing versus Temperature

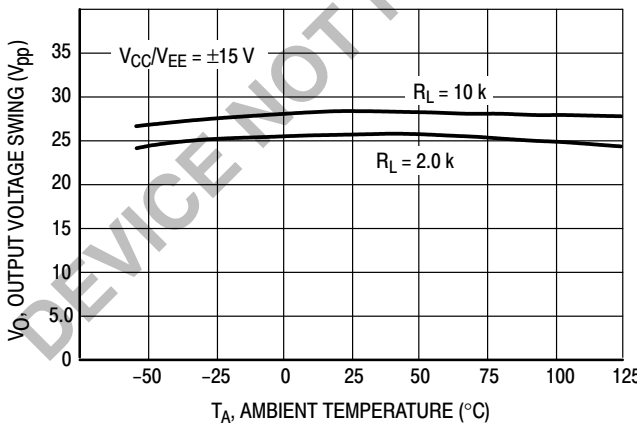


Figure 6. Supply Current per Amplifier versus Temperature

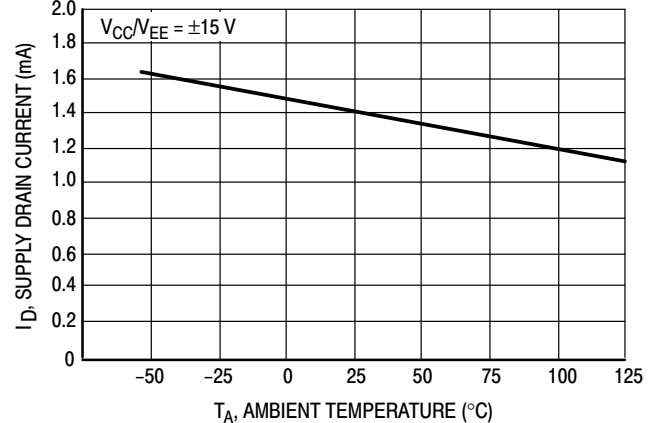


Figure 7. Large-Signal Voltage Gain and Phase Shift versus Frequency

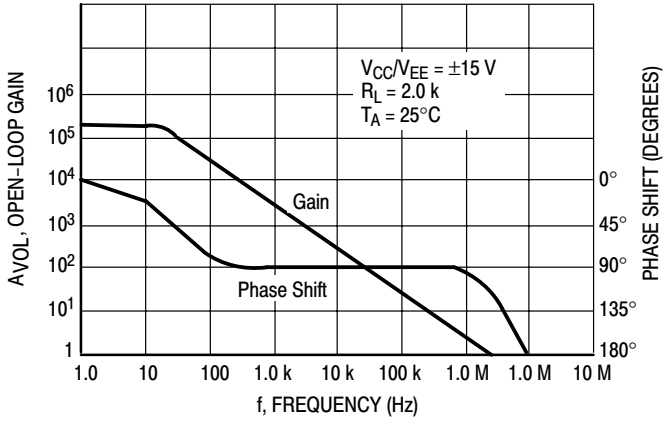


Figure 8. Large-Signal Voltage Gain versus Temperature

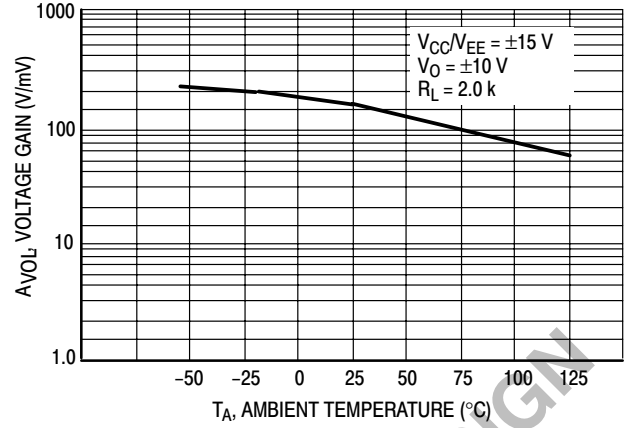


Figure 9. Normalized Slew Rate versus Temperature

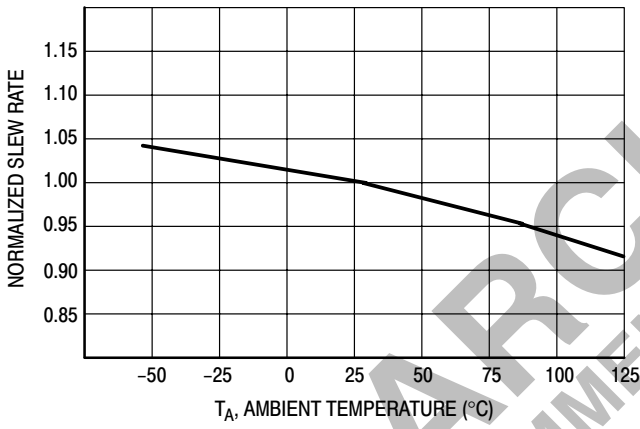


Figure 10. Equivalent Input Noise Voltage versus Frequency

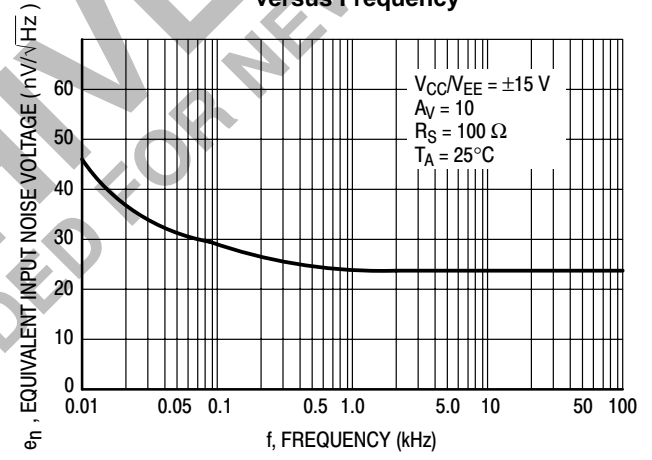
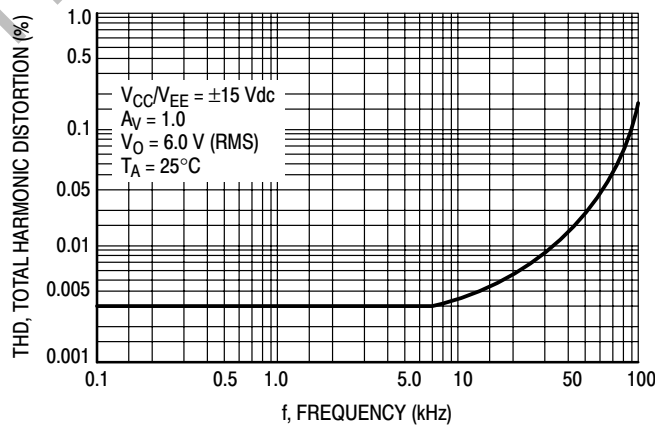


Figure 11. Total Harmonic Distortion versus Frequency



MC34001, B MC34002, B MC34004, B

Representative Circuit Schematic  
(Each Amplifier)

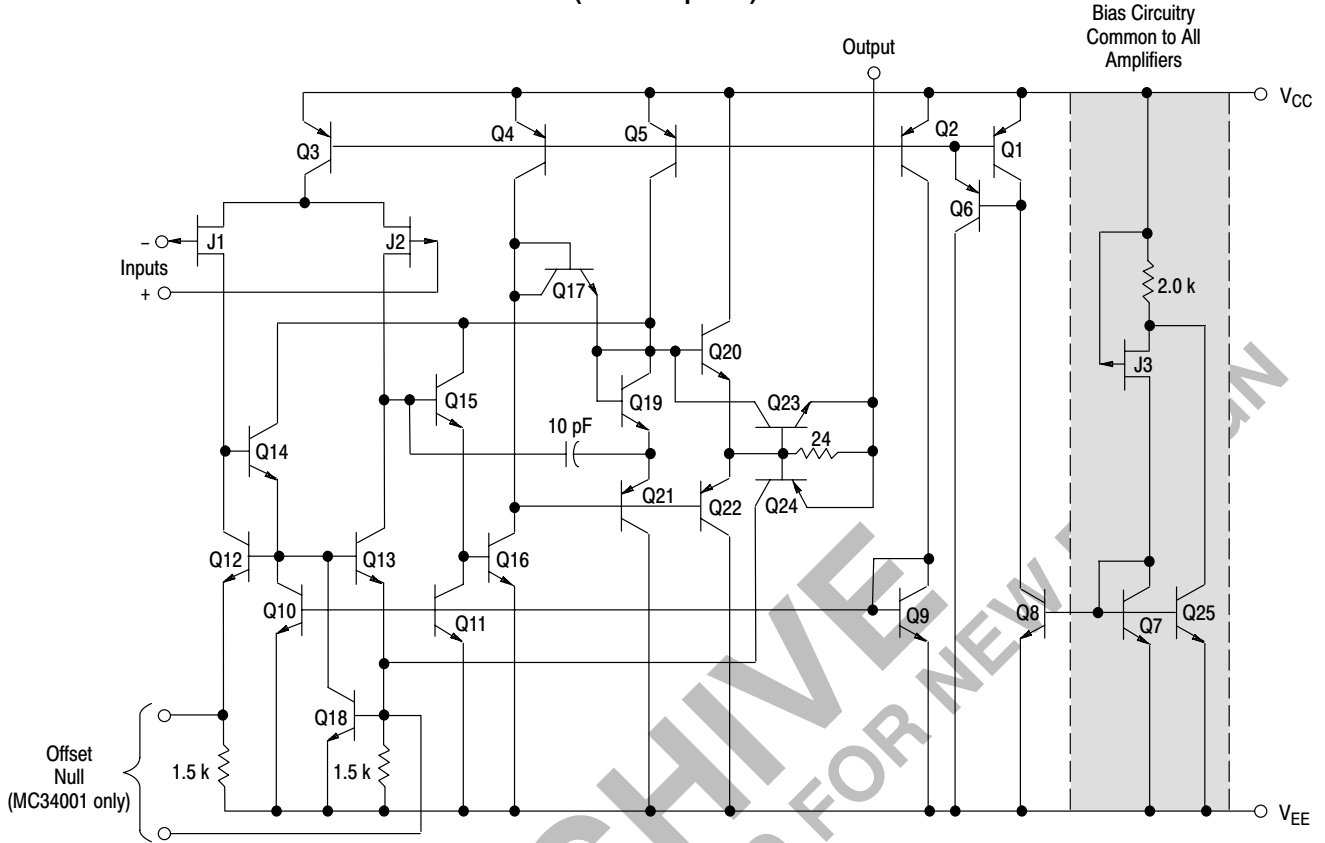
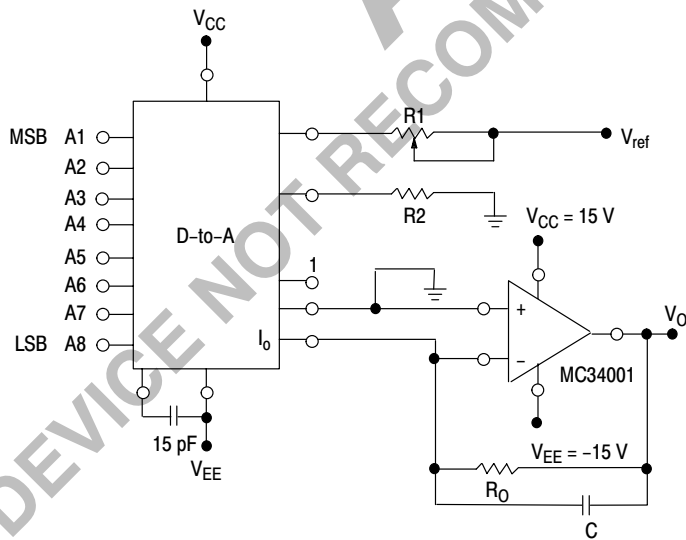


Figure 12. Output Current to Voltage Transformation for a D-to-A Converter



Settling time to within 1/2 LSB is approximately 4.0  $\mu s$  from the time all bits are switched ( $C = 68$  pF).

The value of  $C$  may be selected to minimize overshoot and ringing.

Theoretical  $V_O$

$$V_O = \frac{V_{ref}}{R_1} (R_0) \left[ \frac{A_1}{2} + \frac{A_2}{4} + \frac{A_3}{8} + \frac{A_4}{16} + \frac{A_5}{32} + \frac{A_6}{64} + \frac{A_7}{128} + \frac{A_8}{256} \right]$$

# MC34001, B MC34002, B MC34004, B

Figure 13. Positive Peak Detector

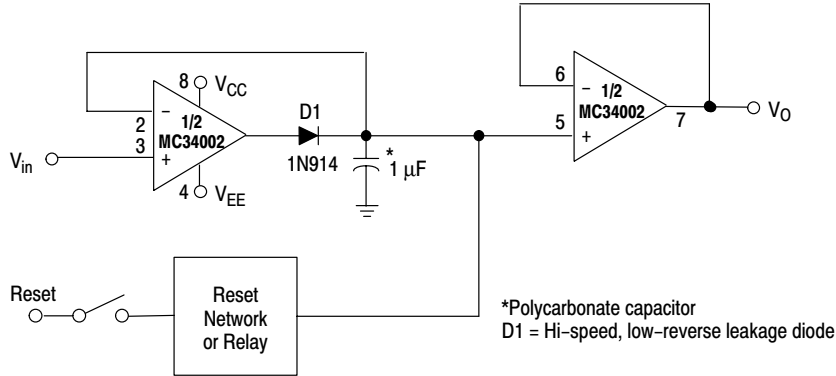
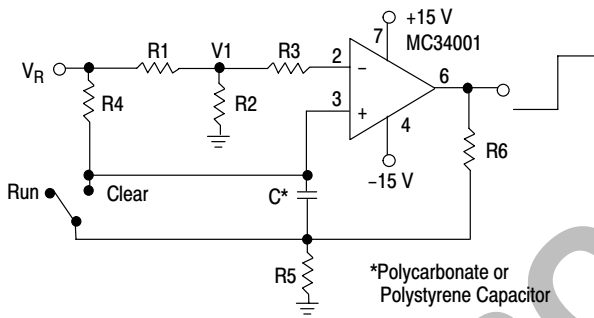


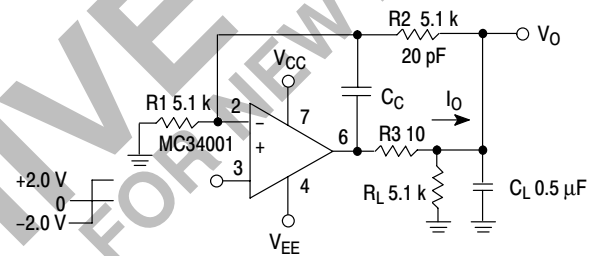
Figure 14. Long Interval RC Timer



Time (t) = R4 Cn (V<sub>R</sub>/V<sub>R</sub>-V<sub>i</sub>), R<sub>3</sub> = R<sub>4</sub>, R<sub>5</sub> = 0.1 R<sub>6</sub>  
 If R<sub>1</sub> = R<sub>2</sub>: t = 0.693 R<sub>4</sub>C

Design Example: 100 Second Timer  
 V<sub>R</sub> = 10 V C = 1.0 μF R<sub>3</sub> = R<sub>4</sub> = 144 M  
 R<sub>6</sub> = 20 k R<sub>5</sub> = 2.0 k R<sub>1</sub> = R<sub>2</sub> = 1.0 k

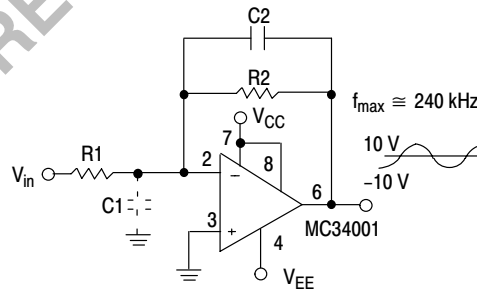
Figure 15. Isolating Large Capacitive Loads



Overshoot < 10%  
 t<sub>s</sub> = 10 μs  
 When driving large C<sub>L</sub>, the V<sub>O</sub> slew rate is determined by C<sub>L</sub> and I<sub>O(max)</sub>:

$$\frac{\Delta V_O}{\Delta t} = \frac{I_O}{C_L} = \frac{0.02}{0.5} \text{ V}/\mu\text{s} = 0.04 \text{ V}/\mu\text{s} \text{ (with } C_L \text{ shown)}$$

Figure 16. Wide BW, Low Noise, Low Drift Amplifier



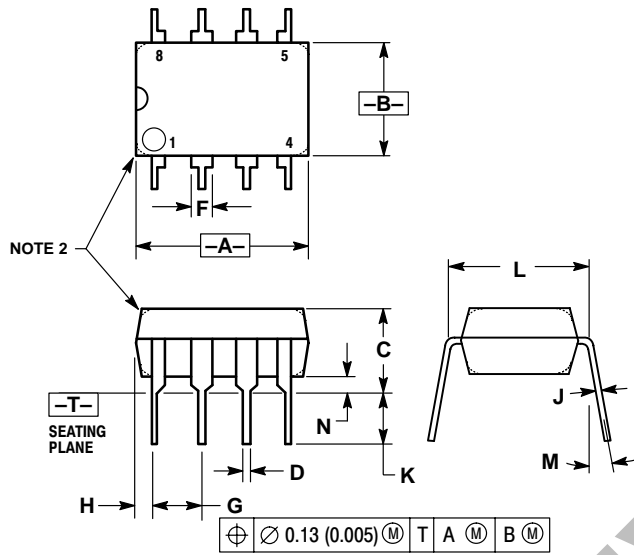
Power BW:  $f_{\max} = \frac{S_r}{2\pi V_p} \approx 240 \text{ kHz}$

Parasitic input capacitance (C<sub>1</sub> ≈ 3.0 pF plus any additional layout capacitance) interacts with feedback elements and creates undesirable high-frequency pole. To compensate add C<sub>2</sub> such that: R<sub>2</sub>C<sub>2</sub> ≈ R<sub>1</sub>C<sub>1</sub>.

MC34001, B MC34002, B MC34004, B

OUTLINE DIMENSIONS

**P SUFFIX**  
 PLASTIC PACKAGE  
 CASE 626-05  
 ISSUE K

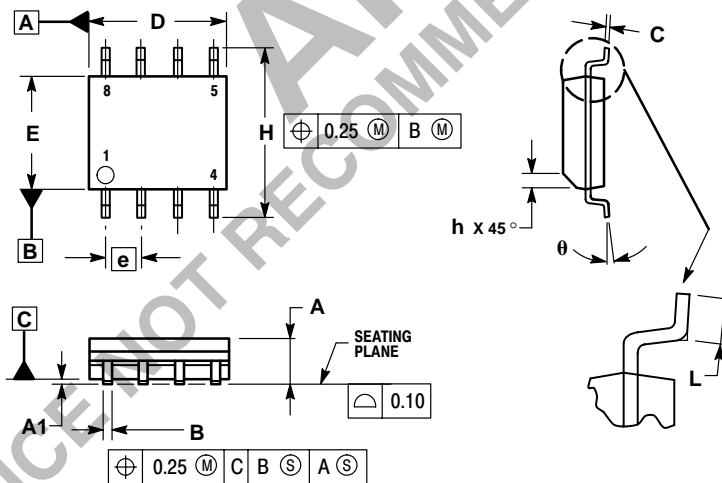


NOTES:

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°	
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.

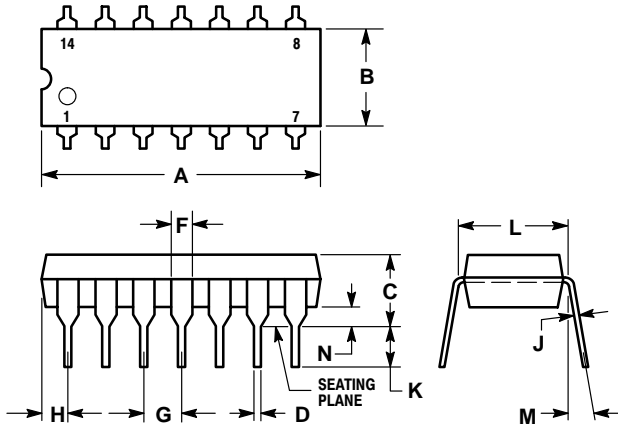
DIM	MILLIMETERS	
	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.35	0.49
C	0.18	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.25
$\theta$	0° 7°	



MC34001, B MC34002, B MC34004, B

OUTLINE DIMENSIONS

P 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


ARCHIVE  
 DEVICE NOT RECOMMENDED FOR NEW DESIGN

MC34001, B MC34002, B MC34004, B  
NOTES

ARCHIVE  
DEVICE NOT RECOMMENDED FOR NEW DESIGN

ARCHIVE  
DEVICE NOT RECOMMENDED FOR NEW DESIGN

ARCHIVE  
RECOMMENDED FOR NEW DESIGN

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