



# JFET Input Operational Amplifiers

These low-cost JFET input operational amplifiers combine two state-of-the-art linear 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.

These devices are available in single, dual and quad operational amplifiers which are pin-compatible with the industry standard MC1741, MC1458, and the MC3403/LM324 bipolar products.

- Input Offset Voltage Options of 6.0 mV and 15 mV Max
- Low Input Bias Current: 30 pA
- Low Input Offset Current: 5.0 pA
- Wide Gain Bandwidth: 4.0 MHz
- High Slew Rate: 13 V/ $\mu$ s
- Low Supply Current: 1.4 mA per Amplifier
- High Input Impedance:  $10^{12} \Omega$

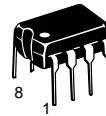
## ORDERING INFORMATION

| Op Amp Function | Device       | Operating Temperature Range                   | Package     |
|-----------------|--------------|---|-------------|
| Single          | TL081CD      | $T_A = 0^\circ \text{ to } +70^\circ\text{C}$ | SO-8        |
|                 | TL081ACP     |   | Plastic DIP |
| Dual            | TL082CD      | $T_A = 0^\circ \text{ to } +70^\circ\text{C}$ | SO-8        |
|                 | TL082ACP     |   | Plastic DIP |
| Quad            | TL084CN, ACN | $T_A = 0^\circ \text{ to } +70^\circ\text{C}$ | Plastic DIP |

# TL081C,AC TL082C,AC TL084C,AC

## JFET INPUT OPERATIONAL AMPLIFIERS

### SEMICONDUCTOR TECHNICAL DATA

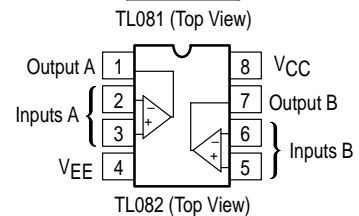
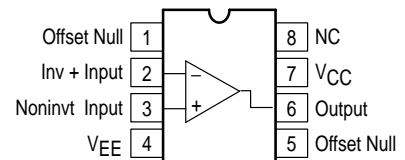


**P SUFFIX**  
PLASTIC PACKAGE  
CASE 626

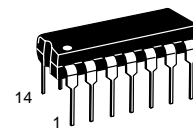
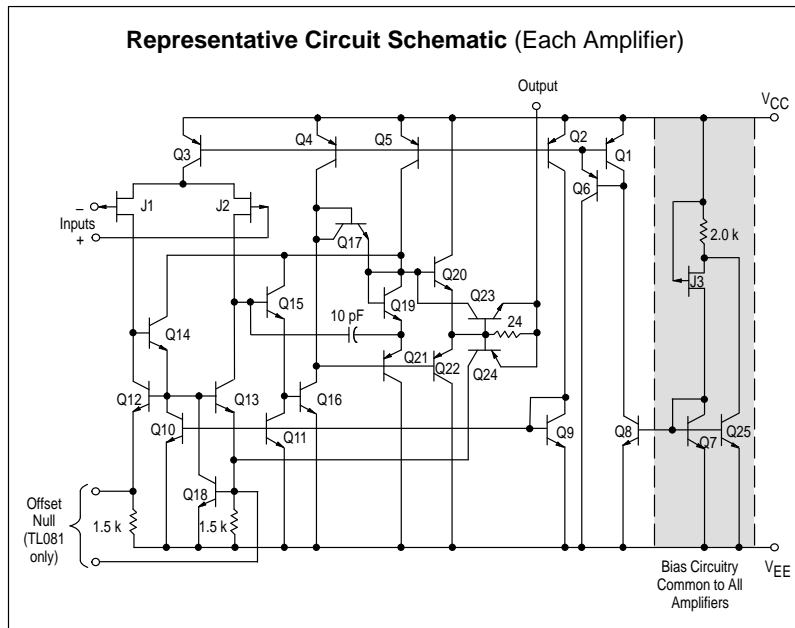


**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751  
(SO-8)

### PIN CONNECTIONS

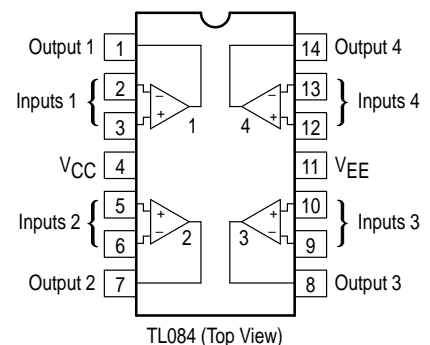


### Representative Circuit Schematic (Each Amplifier)



**N SUFFIX**  
PLASTIC PACKAGE  
CASE 646

### PIN CONNECTIONS



# TL081C,AC TL082C,AC TL084C,AC

## MAXIMUM RATINGS

| Rating   | Symbol                   | Value       | Unit                       |
|--|--------------------------|-------------|----------------------------|
| Supply Voltage   | $V_{CC}$<br>$V_{EE}$     | 18<br>-18   | V                          |
| Differential Input Voltage                                       | $V_{ID}$                 | $\pm 30$    | V                          |
| Input Voltage Range (Note 1)                                     | $V_{IDR}$                | $\pm 15$    | V                          |
| Output Short Circuit Duration (Note 2)                           | $t_{SC}$                 | Continuous  |                            |
| Power Dissipation  |                          |             |                            |
| Plastic Package (N, P)<br>Derate above $T_A = +47^\circ\text{C}$ | $P_D$<br>$1/\theta_{JA}$ | 680<br>10   | mW<br>mW/ $^\circ\text{C}$ |
| Operating Ambient Temperature Range                              | $T_A$                    | 0 to +70    | $^\circ\text{C}$           |
| Storage Temperature Range  | $T_{stg}$                | -65 to +150 | $^\circ\text{C}$           |

- NOTES:** 1. The magnitude of the input voltage must not exceed the magnitude of the supply voltage or 15 V, whichever is less.  
2. The output may be shorted to ground or either supply. Temperature and/or supply voltages must be limited to ensure that power dissipation ratings are not exceeded.  
3. ESD data available upon request.

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = 15\text{ V}$ , $V_{EE} = -15\text{ V}$ , $T_A = T_{low}$ to $T_{high}$ [Note 1].)

| Characteristics   | Symbol    | Min      | Typ    | Max             | Unit |
|---|-----------|----------|--------|-----------------|------|
| Input Offset Voltage ( $R_S \leq 10\text{ k}$ , $V_{CM} = 0$ )<br>TL081C, TL082C<br>TL084C<br>TL08_AC | $V_{IO}$  | -        | -      | 20<br>20<br>7.5 | mV   |
| Input Offset Current ( $V_{CM} = 0$ ) (Note 2)<br>TL08_C<br>TL08_AC                                   | $I_{IO}$  | -        | -      | 5.0<br>3.0      | nA   |
| Input Bias Current ( $V_{CM} = 0$ ) (Note 2)<br>TL08_C<br>TL08_AC                                     | $I_{IB}$  | -        | -      | 10<br>7.0       | nA   |
| Large-Signal Voltage Gain ( $V_O = \pm 10\text{ V}$ , $R_L \geq 2.0\text{ k}$ )<br>TL08_C<br>TL08_AC  | $A_{VOL}$ | 15<br>25 | -<br>- | -<br>-          | V/mV |
| Output Voltage Swing (Peak-to-Peak)<br>( $R_L \geq 10\text{ k}$ )<br>( $R_L \geq 2.0\text{ k}$ )      | $V_O$     | 24<br>20 | -<br>- | -<br>-          | V    |

- NOTES:** 1.  $T_{low} = 0^\circ\text{C}$  for TL081AC,C TL082AC,C TL084AC,C  $T_{high} = 70^\circ\text{C}$  for TL081AC TL082AC,C TL084AC,C  
2. Input Bias currents of JFET input op amps approximately double for every  $10^\circ\text{C}$  rise in Junction Temperature as shown in Figure 3. To maintain junction temperature as close to ambient temperature as possible, pulse techniques must be used during testing.

Figure 1. Unity Gain Voltage Follower

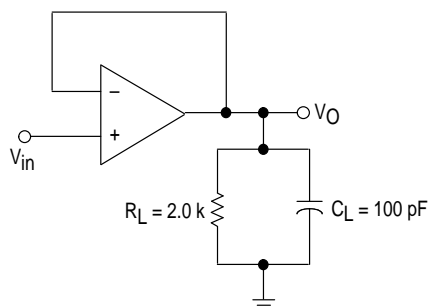
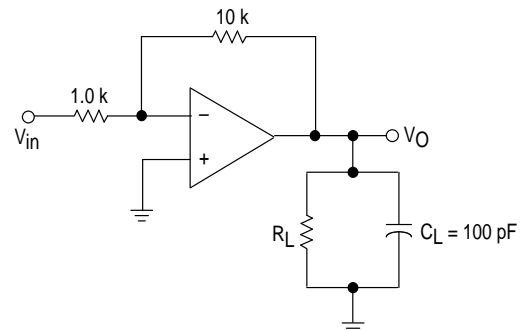


Figure 2. Inverting Gain of 10 Amplifier



# TL081C,AC TL082C,AC TL084C,AC

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

| Characteristics  | Symbol                   | Min                  | Typ                | Max             | Unit                         |
|--|--------------------------|----------------------|--------------------|-----------------|------------------------------|
| Input Offset Voltage ( $R_S \leq 10\text{ k}$ , $V_{CM} = 0$ )<br>TL081C, TL082C<br>TL084C<br>TL08_AC                  | $V_{IO}$                 | –                    | 5.0<br>5.0<br>3.0  | 15<br>15<br>6.0 | mV                           |
| Average Temperature Coefficient of Input Offset Voltage<br>$R_S = 50\ \Omega$ , $T_A = T_{low}$ to $T_{high}$ (Note 1) | $\Delta V_{IO}/\Delta T$ | –                    | 10                 | –               | $\mu\text{V}/^\circ\text{C}$ |
| Input Offset Current ( $V_{CM} = 0$ ) (Note 2)<br>TL08_C<br>TL08_AC  | $I_{IO}$                 | –                    | 5.0<br>5.0         | 200<br>100      | $\mu\text{A}$                |
| Input Bias Current ( $V_{CM} = 0$ ) (Note 2)<br>TL08_C<br>TL08_AC  | $I_{IB}$                 | –                    | 30<br>30           | 400<br>200      | $\mu\text{A}$                |
| Input Resistance   | $r_i$                    | –                    | $10^{12}$          | –               | $\Omega$                     |
| Common Mode Input Voltage Range<br>TL08_C<br>TL08_AC   | $V_{ICR}$                | $\pm 10$<br>$\pm 11$ | 15, –12<br>15, –12 | –<br>–          | V                            |
| Large Signal Voltage Gain ( $V_O = \pm 10\text{ V}$ , $R_L \geq 2.0\text{ k}$ )<br>TL08_C<br>TL08_AC                   | $A_{VOL}$                | 25<br>50             | 150<br>150         | –<br>–          | V/mV                         |
| Output Voltage Swing (Peak-to-Peak)<br>( $R_L = 10\text{ k}$ )   | $V_O$                    | 24                   | 28                 | –               | V                            |
| Common Mode Rejection Ratio ( $R_S \leq 10\text{ k}$ )<br>TL08_C<br>TL08_AC  | CMRR                     | 70<br>80             | 100<br>100         | –<br>–          | dB                           |
| Supply Voltage Rejection Ratio ( $R_S \leq 10\text{ k}$ )<br>TL08_C<br>TL08_AC   | PSRR                     | 70<br>80             | 100<br>100         | –<br>–          | dB                           |
| Supply Current (Each Amplifier)  | $I_D$                    | –                    | 1.4                | 2.8             | mA                           |
| Unity Gain Bandwidth   | BW                       | –                    | 4.0                | –               | MHz                          |
| Slew Rate (See Figure 1)<br>$V_{in} = 10\text{ V}$ , $R_L = 2.0\text{ k}$ , $C_L = 100\text{ pF}$                      | SR                       | –                    | 13                 | –               | V/ $\mu\text{s}$             |
| Rise Time (See Figure 1)   | $t_r$                    | –                    | 0.1                | –               | $\mu\text{s}$                |
| Overshoot ( $V_{in} = 20\text{ mV}$ , $R_L = 2.0\text{ k}$ , $C_L = 100\text{ pF}$ )                                   | OS                       | –                    | 10                 | –               | %                            |
| Equivalent Input Noise Voltage<br>$R_S = 100\ \Omega$ , $f = 1000\text{ Hz}$   | $e_n$                    | –                    | 25                 | –               | $\text{nV}/\sqrt{\text{Hz}}$ |
| Channel Separation<br>$A_V = 100$  | CS                       | –                    | 120                | –               | dB                           |

**NOTES:** 1.  $T_{low} = 0^\circ\text{C}$  for TL081AC,C TL082AC,C TL084AC,C  
 $T_{high} = 70^\circ\text{C}$  for TL081AC TL082AC,C TL084AC,C

2. Input Bias currents of JFET input op amps approximately double for every  $10^\circ\text{C}$  rise in Junction Temperature as shown in Figure 3. To maintain junction temperature as close to ambient temperature as possible, pulse techniques must be used during testing.

Figure 3. Input Bias Current versus Temperature

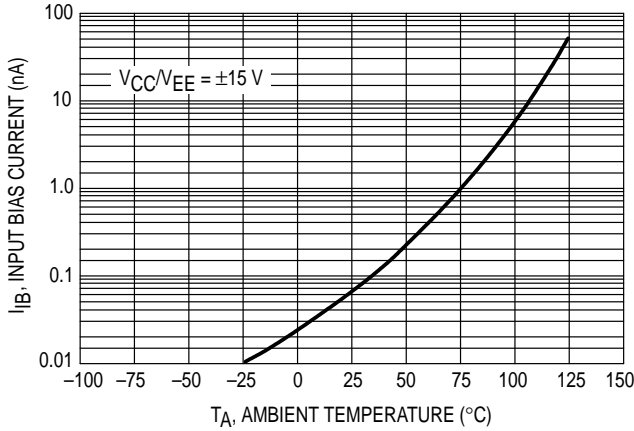


Figure 4. Output Voltage Swing versus Frequency

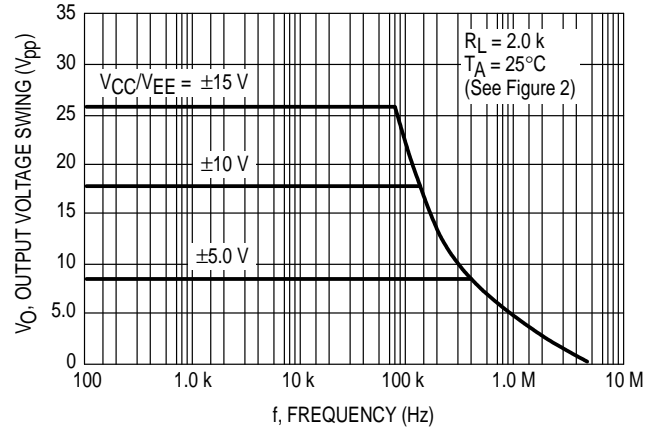


Figure 5. Output Voltage Swing versus Load Resistance

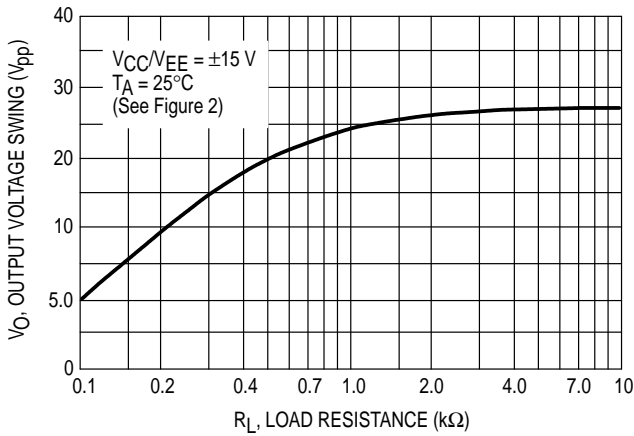


Figure 6. Output Voltage Swing versus Supply Voltage

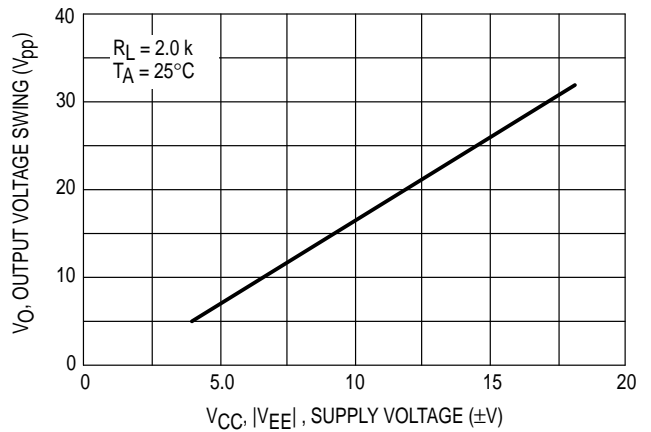


Figure 7. Output Voltage Swing versus Temperature

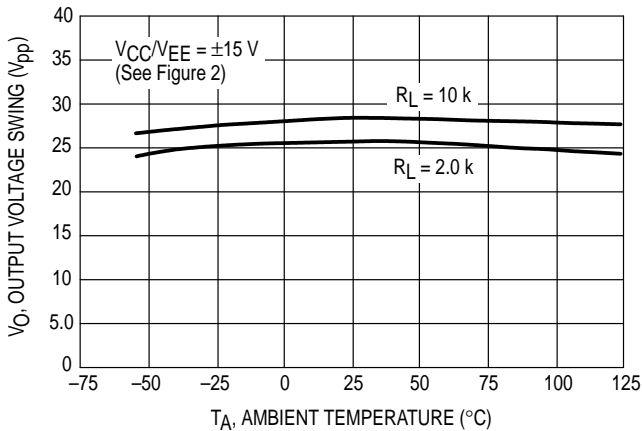
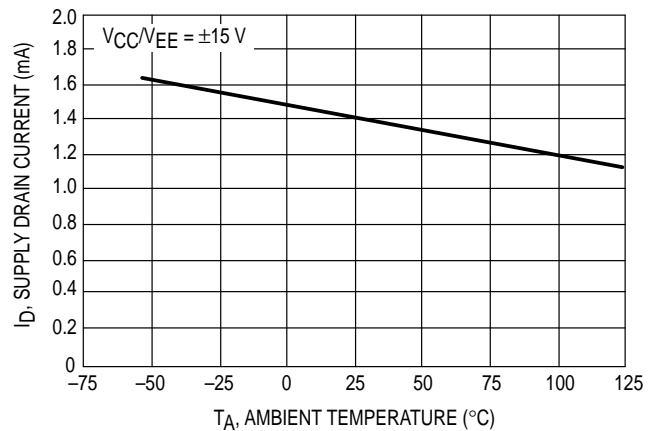
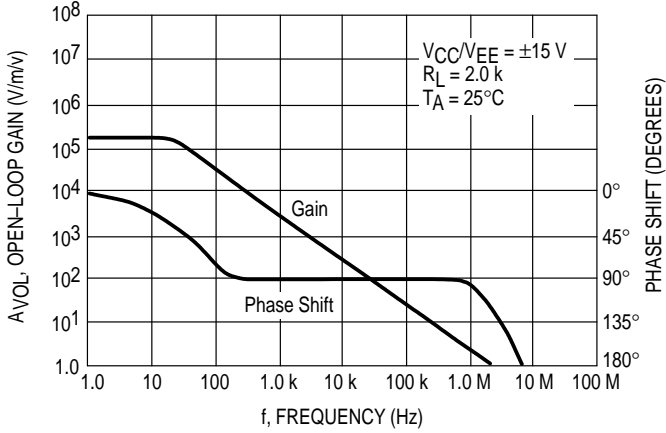


Figure 8. Supply Current per Amplifier versus Temperature

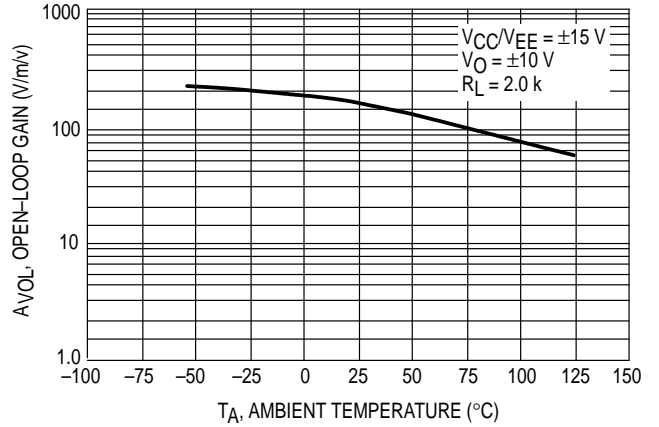


# TL081C,AC TL082C,AC TL084C,AC

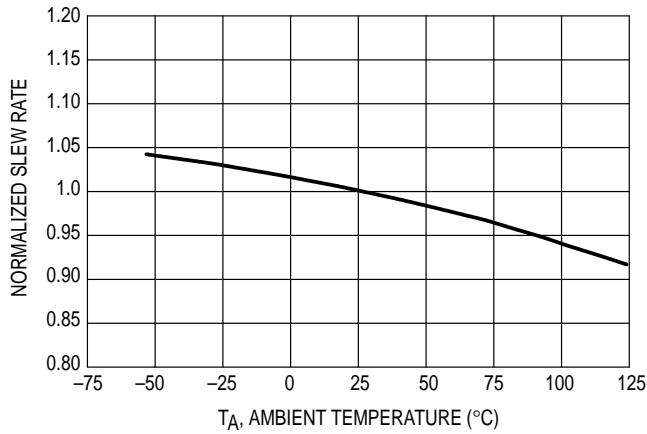
**Figure 9. Large Signal Voltage Gain and Phase Shift versus Frequency**



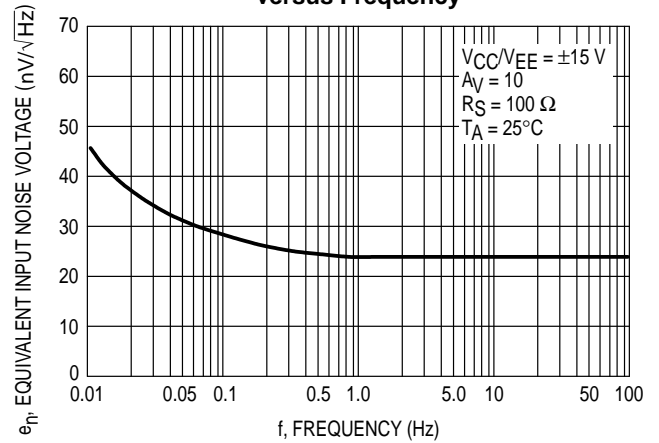
**Figure 10. Large Signal Voltage Gain versus Temperature**



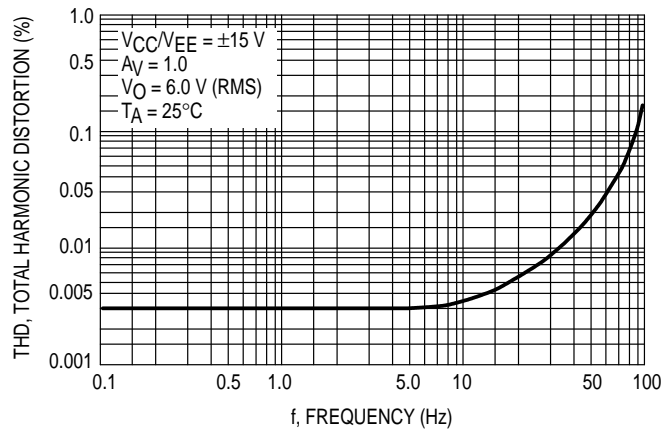
**Figure 11. Normalized Slew Rate versus Temperature**



**Figure 12. Equivalent Input Noise Voltage versus Frequency**



**Figure 13. Total Harmonic Distortion versus Frequency**



# TL081C,AC TL082C,AC TL084C,AC

Figure 14. Positive Peak Detector

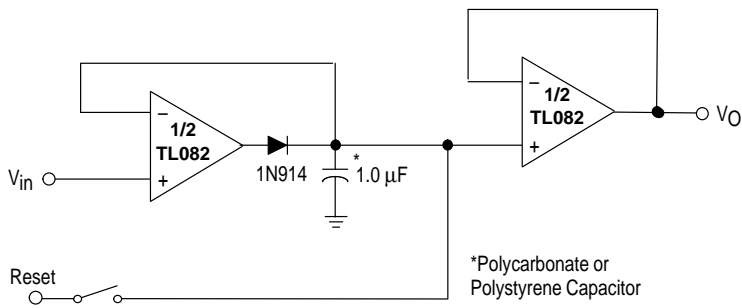


Figure 15. Voltage Controlled Current Source

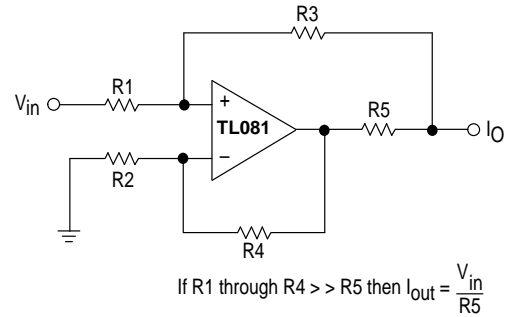
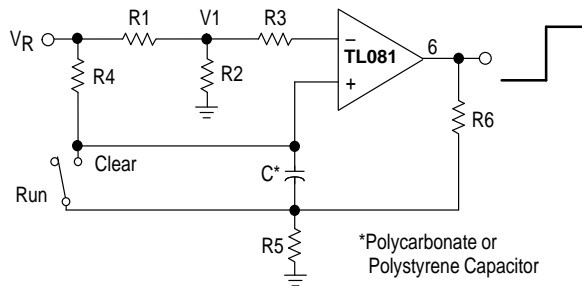


Figure 16. Long Interval RC Timer

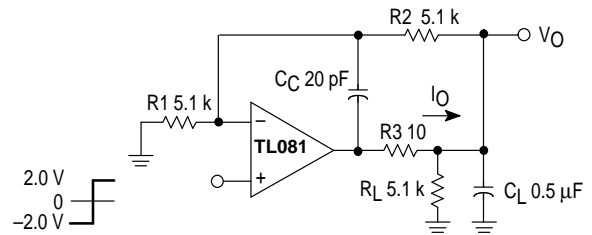


$$\text{Time (t)} = R_4 C \ln(V_R / (V_R - V_i)), \quad R_3 = R_4, \quad R_5 = 0.1 R_6$$

$$\text{If } R_1 = R_2: t = 0.693 R_4 C$$

Design Example: 100 Second Timer  
 $V_R = 10 \text{ V}$     $C = 1.0 \text{ mF}$     $R_3 = R_4 = 144 \text{ M}$   
 $R_6 = 20 \text{ k}$     $R_5 = 2.0 \text{ k}$     $R_1 = R_2 = 1.0 \text{ k}$

Figure 17. Isolating Large Capacitive Loads



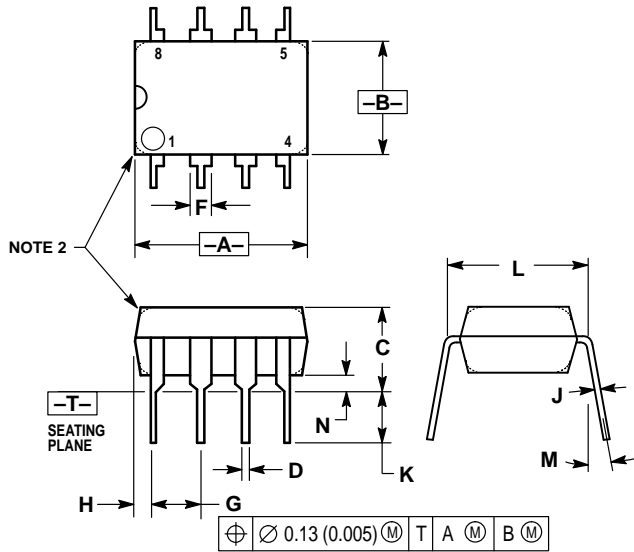
- Overshoot < 10%
- $t_s = 10 \mu\text{s}$
- When driving large  $C_L$ , the  $V_O$  slew rate is determined by  $C_L$  and  $I_{O(\text{max})}$ :

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

# TL081C,AC TL082C,AC TL084C,AC

## OUTLINE DIMENSIONS

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

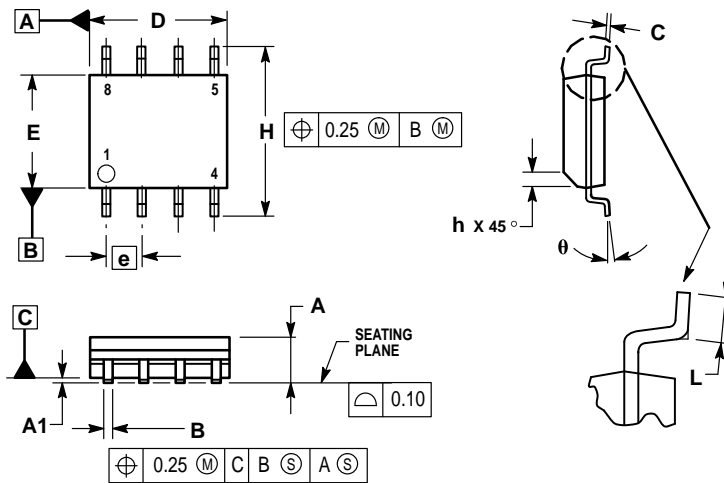


NOTES:

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 S



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°       |      |

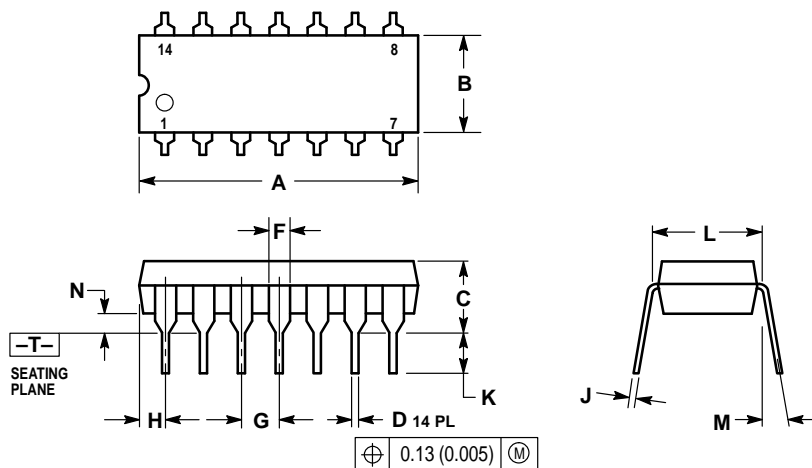
# TL081C,AC TL082C,AC TL084C,AC

## OUTLINE DIMENSIONS

N SUFFIX  
PLASTIC PACKAGE  
CASE 646-06  
ISSUE M

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.



| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.715     | 0.770 | 18.16       | 18.80 |
| 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   | 0.290     | 0.310 | 7.37        | 7.87  |
| M   | — 10°     |       | — 10°       |       |
| N   | 0.015     | 0.039 | 0.38        | 1.01  |

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