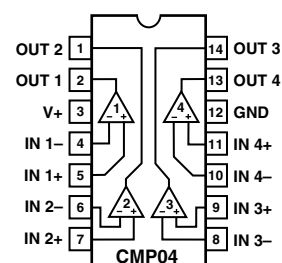


### FEATURES

**High Gain:** 200 V/mV Typ  
**Single- or Dual-Supply Operation**  
**Input Voltage Range Includes Ground**  
**Low Power Consumption (1.5 mW/Comparator)**  
**Low Input Bias Current:** 100 nA Max  
**Low Input Offset Current:** 10 nA Max  
**Low Offset Voltage:** 1 mV Max  
**Low Output Saturation Voltage:** 250 mV @ 4 mA  
**Logic Output Compatible with TTL, DTL, ECL, MOS, and CMOS**  
**Directly Replaces LM139/LM239/LM339 Comparators**

### PIN CONNECTIONS

#### 14-Lead SOIC



### GENERAL DESCRIPTION

Four precision independent comparators comprise the CMP04. Performance highlights include a very low offset voltage, low output saturation voltage, and high gain in a single-supply design. The input voltage range includes ground for single-supply operation and  $V^-$  for split supplies. A low power supply current of 2 mA, which is independent of supply voltage, makes this the preferred comparator for precision applications requiring minimal power consumption. Maximum logic interface flexibility is offered by the open-collector TTL output.

### TYPICAL INTERFACE

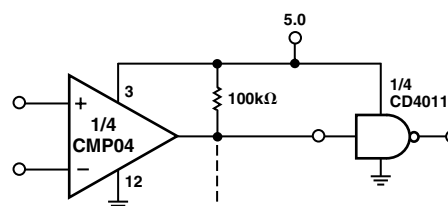


Figure 2a. Driving CMOS

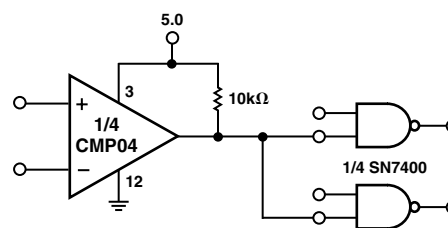


Figure 2b. Driving TTL

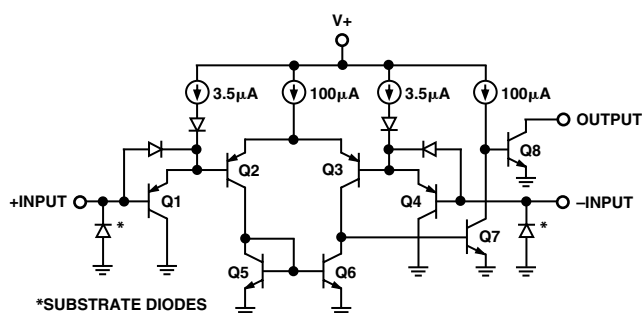


Figure 1. Simplified Schematic (1/4 CMP04)

### REV. D

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# CMP04—SPECIFICATIONS

## ELECTRICAL CHARACTERISTICS

(@  $V_+ = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

| Parameter                    | Symbol     | Conditions                                                                                                           | Min | Typ | Max         | Unit          |
|------------------------------|------------|----------------------------------------------------------------------------------------------------------------------|-----|-----|-------------|---------------|
| Input Offset Voltage         | $V_{OS}$   | $R_S = 0\ \Omega$ , $R_L = 5.1\text{ k}\Omega$ , $V_O = 1.4\text{ V}^1$                                              |     | 0.4 | 1           | mV            |
| Input Offset Current         | $I_{OS}$   | $I_{IN}(+) - I_{IN}(-)$ , $R_L = 5.1\text{ k}\Omega$ , $V_O = 1.4\text{ V}$                                          |     | 2   | 10          | nA            |
| Input Bias Current           | $I_B$      | $I_{IN}(+)$ or $I_{IN}(-)$                                                                                           |     | 25  | 100         | nA            |
| Voltage Gain                 | $A_V$      | $R_L \geq 15\text{ k}\Omega$ , $V_+ = 15\text{ V}^2$                                                                 | 80  | 200 |             | V/mV          |
| Large Signal Response Time   | $t_r$      | $V_{IN} = \text{TTL Logic Swing}$ , $V_{REF} = 1.4\text{ V}^3$<br>$V_{RL} = 5\text{ V}$ , $R_L = 5.1\text{ k}\Omega$ |     | 300 |             | ns            |
| Small Signal Response Time   | $t_r$      | $V_{IN} = 100\text{ mV Step}^3$ , $5\text{ mV Overdrive}$<br>$V_{RL} = 5\text{ V}$ , $R_L = 5.1\text{ k}\Omega$      |     | 1.3 |             | $\mu\text{s}$ |
| Input Voltage Range          | CMVR       | Note 4                                                                                                               | 0   |     | $V_+ - 1.5$ | V             |
| Common-Mode Rejection Ratio  | CMRR       | Notes 2, 5                                                                                                           | 80  | 100 |             | dB            |
| Power Supply Rejection Ratio | PSRR       | $V_+ = 5\text{ V to }18\text{ V}^2$                                                                                  | 80  | 100 |             | dB            |
| Saturation Voltage           | $V_{OL}$   | $V_{IN}(-) \geq 1\text{ V}$ , $V_{IN}(+) = 0$ , $I_{SINK} \leq 4\text{ mA}$                                          |     | 250 | 400         | mV            |
| Output Sink Current          | $I_{SINK}$ | $V_{IN}(-) \geq 1\text{ V}$ , $V_{IN}(+) = 0$ , $V_O \leq 1.5\text{ V}$                                              | 6   | 16  |             | mA            |
| Output Leakage Current       | $I_{LEAK}$ | $V_{IN}(+) \geq 1\text{ V}$ , $V_{IN}(-) = 0$ , $V_O = 30\text{ V}$                                                  |     | 0.1 | 100         | nA            |
| Supply Current               | $I_+$      | $R_L = \infty$ , All Comps $V_+ = 30\text{ V}$                                                                       |     | 0.8 | 2.0         | mA            |

### NOTES

<sup>1</sup>At output switch point,  $V_O = 1.4\text{ V}$ ,  $R_S = 0\ \Omega$  with  $V_+$  from  $5\text{ V}$ , and over the full input common-mode range ( $0\text{ V to }V_+ - 1.5\text{ V}$ ).

<sup>2</sup>Guaranteed by design.

<sup>3</sup>Sample tested.

<sup>4</sup>The input common-mode voltage or input signal voltage should not be allowed to go negative by more than  $0.3\text{ V}$ . The upper end of the common-mode voltage range is  $V_+ - 1.5\text{ V}$ , but either or both inputs can go to  $30\text{ V}$  without damage.

<sup>5</sup> $R_L \geq 15\text{ k}\Omega$ ,  $V_+ = 15\text{ V}$ ,  $V_{CM} = 1.5\text{ V to }13.5\text{ V}$ .

Specifications subject to change without notice.

### ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

|                                            |                            |
|--------------------------------------------|----------------------------|
| Supply Voltage                             | +36 V or $\pm 18\text{ V}$ |
| Differential Input Voltage                 | 36 V dc                    |
| Input Voltage                              | -0.3 V to +36 V            |
| Operating Temperature Range                |                            |
| CMP04FS                                    | -40°C to +85°C             |
| Junction Temperature ( $T_J$ )             | -65°C to +150°C            |
| Storage Temperature Range                  | -65°C to +150°C            |
| Input Current ( $V_{IN} < -3.0\text{ V}$ ) | 50 mA                      |
| Output Short Circuit to GND                | Continuous                 |
| Lead Temperature (Soldering, 60 sec)       | 300°C                      |

| Package Type | $\theta_{JA}^2$ | $\theta_{JC}$ | Unit |
|--------------|-----------------|---------------|------|
| 14-Lead SOIC | 120             | 36            | °C/W |

### NOTES

<sup>1</sup>Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

<sup>2</sup> $\theta_{JA}$  is specified for worst-case mounting conditions, i.e.,  $\theta_{JA}$  is specified for device soldered to printed circuit board for SOIC package.

### ORDERING GUIDE

| Model   | $T_A = 25^\circ\text{C}$<br>$V_{OS}$ | Temperature<br>Ranges | Package<br>Descriptions | Package<br>Options |
|---------|--------------------------------------|-----------------------|-------------------------|--------------------|
| CMP04FS | 1 mV                                 | -40°C to +85°C        | 14-Lead SOIC            | R-14               |

### CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the CMP04 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



# ELECTRICAL CHARACTERISTICS (@ $V_+ = 5\text{ V}$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ for CMP04FS, unless otherwise noted.)

| Parameter                    | Symbol     | Conditions                                           | Min | CMP04F <sup>1</sup><br>Typ | Max         | Unit          |
|------------------------------|------------|------------------------------------------------------|-----|----------------------------|-------------|---------------|
| Input Offset Voltage         | $V_{OS}$   | $R_S = 0\ \Omega$ , $R_L = 5.1\text{ k}\Omega$       |     | 1                          | 2           | mV            |
|                              |            | $V_O = 1.4\text{ V}^2$                               |     | 1                          | 2           | mV            |
| Input Offset Current         | $I_{OS}$   | $I_{IN}(+) - I_{IN}(-)$                              |     | 4                          | 20          | nA            |
|                              |            | $R_L = 5.1\text{ k}\Omega$                           |     | 4                          | 20          | nA            |
|                              |            | $V_O = 1.4\text{ V}$                                 |     | 4                          | 20          | nA            |
| Input Bias Current           | $I_B$      | $I_{IN}(+)$ or $I_{IN}(-)$                           |     | 40                         | 200         | nA            |
| Voltage Gain                 | $A_V$      | $R_L \geq 15\text{ k}\Omega$ , $V_+ = 15\text{ V}^3$ | 70  | 125                        |             | V/mV          |
| Large Signal Response Time   | $t_r$      | $V_{IN} = \text{TTL Logic Swing}$                    |     | 300                        |             | ns            |
|                              |            | $V_{REF} = 1.4\text{ V}^4$                           |     | 300                        |             | ns            |
|                              |            | $V_{RL} = 5\text{ V}$ , $R_L = 5.1\text{ k}\Omega$   |     | 300                        |             | ns            |
| Small Signal Response Time   | $t_r$      | $V_{IN} = 100\text{ mV Step}^4$                      |     | 1.3                        |             | $\mu\text{s}$ |
|                              |            | 5 mV Overdrive                                       |     | 1.3                        |             | $\mu\text{s}$ |
|                              |            | $V_{RL} = 5\text{ V}$ , $R_L = 5.1\text{ k}\Omega$   |     | 1.3                        |             | $\mu\text{s}$ |
| Input Voltage Range          | CMVR       | Note 5                                               | 0   |                            | $V_+ - 1.5$ | V             |
| Common-Mode Rejection Ratio  | CMRR       | Notes 1, 3                                           | 60  | 100                        |             | dB            |
| Power Supply Rejection Ratio | PSRR       | $V_+ = 5\text{ V}$ to $18\text{ V}$                  | 80  | 100                        |             | dB            |
| Saturation Voltage           | $V_{OL}$   | $V_{IN}(-) \geq 1\text{ V}$ , $V_{IN}(+) = 0$ ,      |     | 250                        | 700         | mV            |
|                              |            | $I_{SINK} \leq 4\text{ mA}$                          |     | 250                        | 700         | mV            |
| Output Sink Current          | $I_{SINK}$ | $V_{IN}(-) \geq 1\text{ V}$ ,                        | 5   | 16                         |             | mA            |
|                              |            | $V_{IN}(+) = 0$ , $V_O \leq 1.5\text{ V}$            | 5   | 16                         |             | mA            |
| Output Leakage Current       | $I_{LEAK}$ | $V_{IN}(+) \geq 1\text{ V}$ ,                        |     | 0.1                        | 200         | nA            |
|                              |            | $V_{IN}(-) = 0$ , $V_O = 30\text{ V}$                |     | 0.1                        | 200         | nA            |
| Supply Current               | $I_+$      | $R_L = \infty$ , All Comps                           |     | 1.2                        | 3.0         | mA            |
|                              |            | $V_+ = 30\text{ V}$                                  |     | 1.2                        | 3.0         | mA            |

## NOTES

<sup>1</sup> $R_L \geq 15\text{ k}\Omega$ ,  $V_+ = 15\text{ V}$ ,  $V_{CM} = 1.5\text{ V}$  to  $13.5\text{ V}$ .

<sup>2</sup>At output switch point,  $V_O = 1.4\text{ V}$ ,  $R_S = 0\ \Omega$  with  $V_+$  from  $5\text{ V}$ ; and over the full input common-mode range ( $0\text{ V}$  to  $V_+ - 1.5\text{ V}$ ).

<sup>3</sup>Guaranteed by design.

<sup>4</sup>Sample tested.

<sup>5</sup>The input common-mode voltage or input signal voltage should not be allowed to go negative by more than  $0.3\text{ V}$ . The upper end of the common-mode voltage range is  $V_+ - 1.5\text{ V}$ , but either or both inputs can go to  $+30\text{ V}$  without damage.

Specifications subject to change without notice.

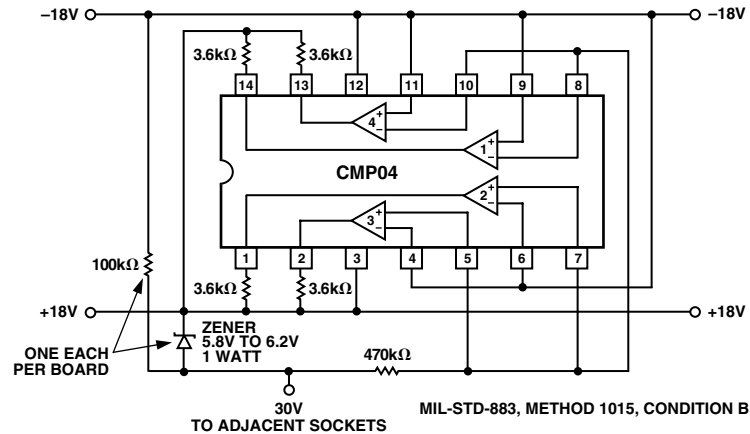
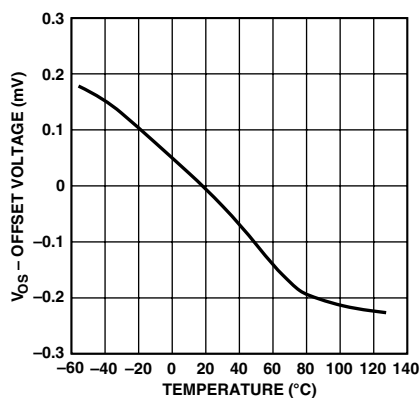
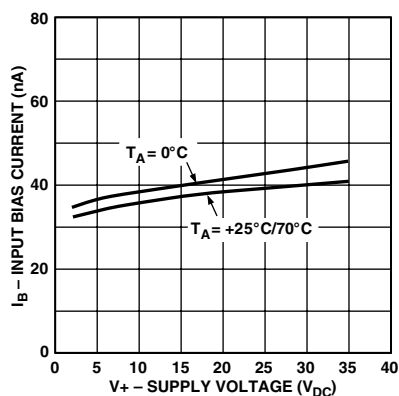


Figure 3. Burn-In Circuit

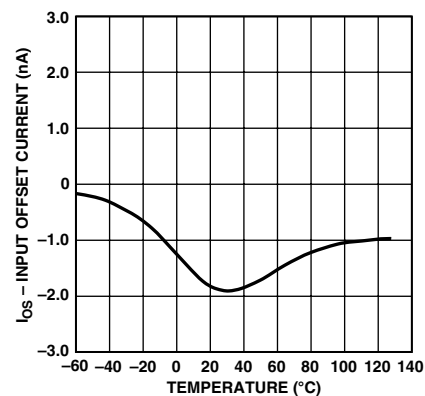
# CMP04—Typical Performance Characteristics



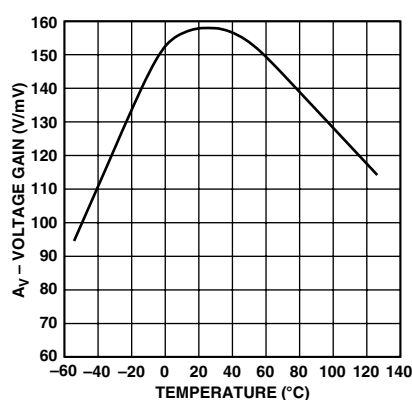
TPC 1. Offset Voltage vs. Temperature



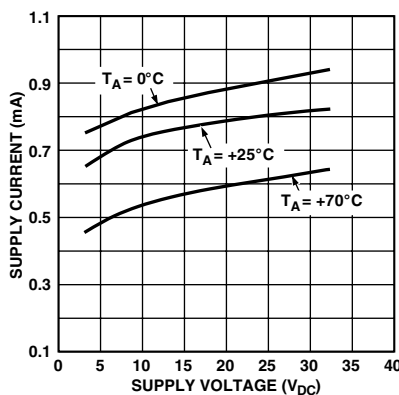
TPC 2. Input Bias Current vs.  $V_+$  and Temperature



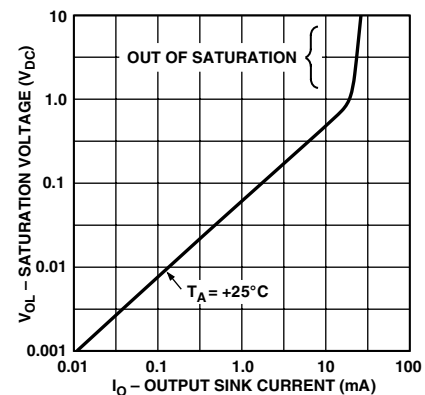
TPC 3. Input Offset Current vs. Temperature



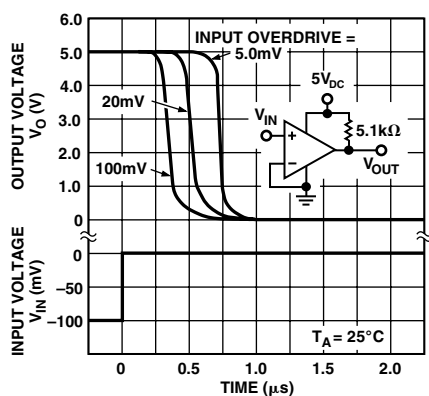
TPC 4. Voltage Gain vs. Temperature



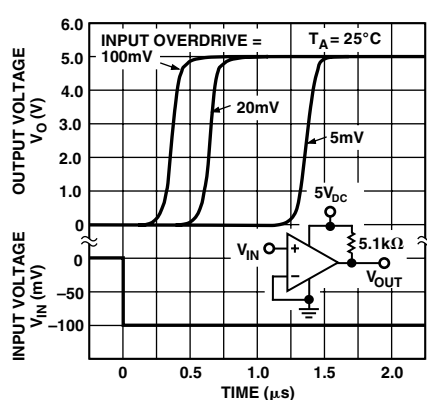
TPC 5. Supply Current vs. Supply Voltage



TPC 6. Output Voltage vs. Output Current and Temperature



TPC 7. Response Time for Various Input Overdrives—Negative Transition



TPC 8. Response Time for Various Input Overdrives—Positive Transition

## TYPICAL APPLICATIONS

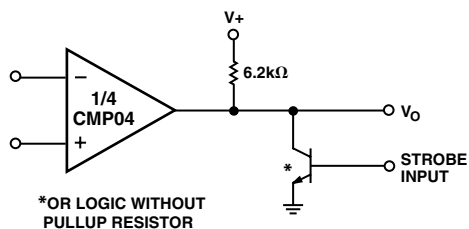


Figure 4. Output Strobbing

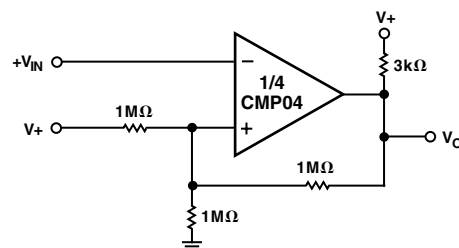


Figure 7. Inverting Comparator with Hysteresis

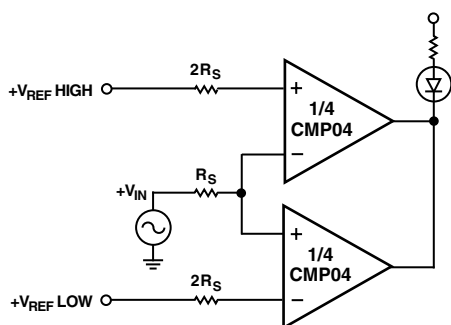


Figure 5. Limit Comparator

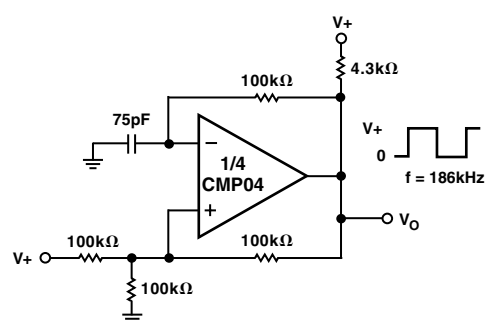


Figure 8. Square Wave Oscillator

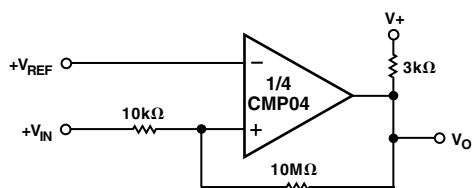


Figure 6. Noninverting Comparator with Hysteresis

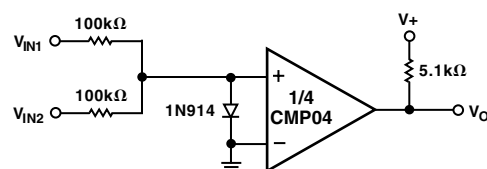


Figure 9. Comparing Input Voltages of Opposite Polarity

# CMP04

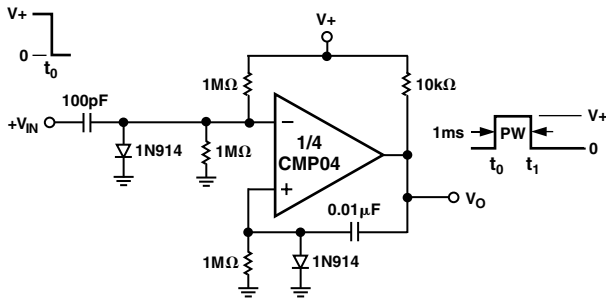


Figure 10. One-Shot Multivibrator

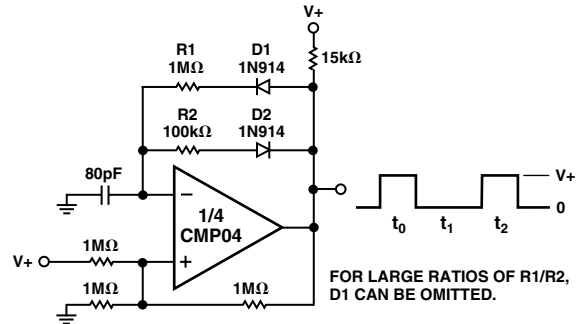


Figure 12. Pulse Generator

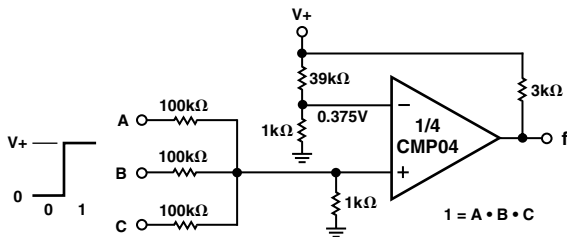


Figure 11. AND Gate

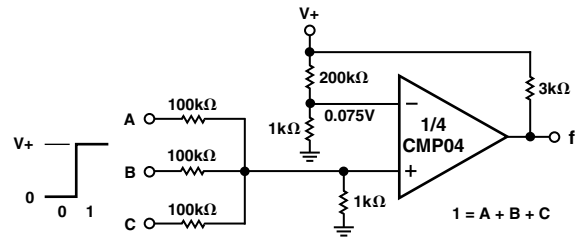


Figure 13. OR Gate

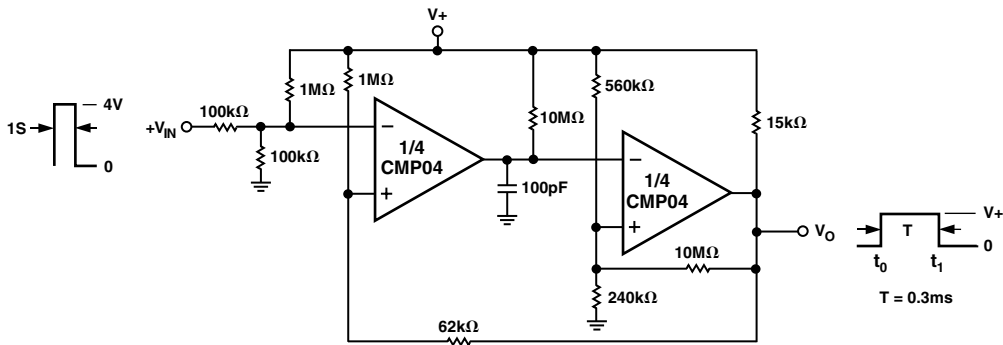


Figure 14. One-Shot Multivibrator with Input Lockout

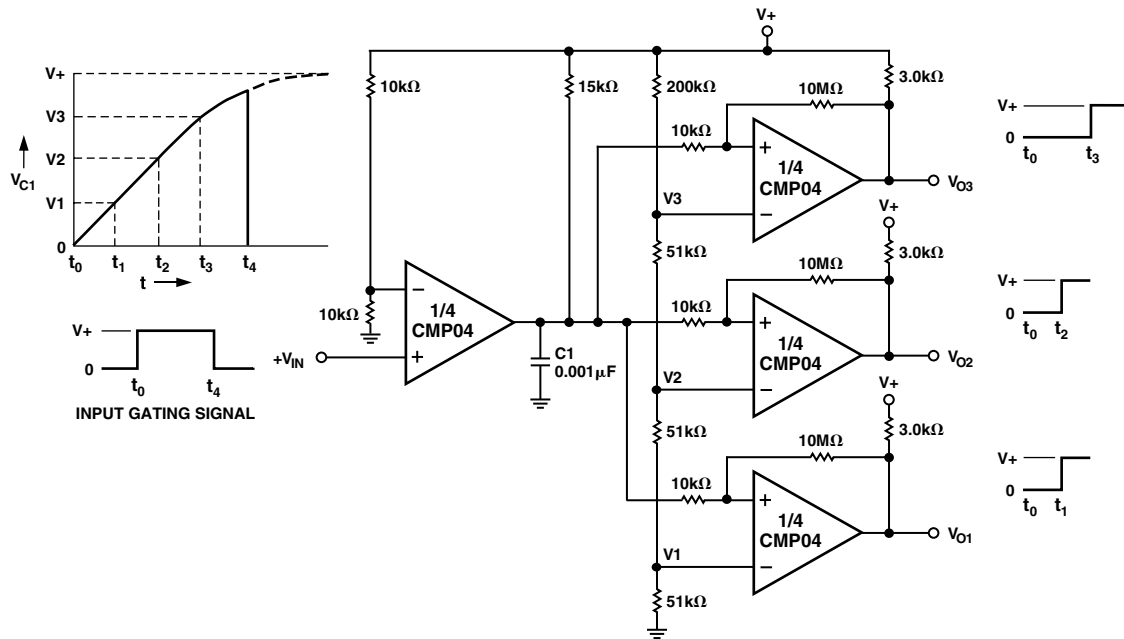
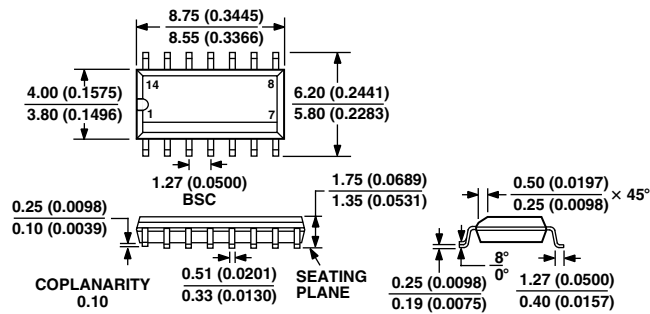


Figure 15. Time Delay Generator

OUTLINE DIMENSIONS

14-Lead Standard Small Outline Package [SOIC]  
Narrow Body  
(R-14)

Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MS-012AB  
CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS  
(IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR  
REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN

Revision History

| Location                                                                                            | Page   |
|-----------------------------------------------------------------------------------------------------|--------|
| 3/03—Data Sheet changed from REV. C to REV. D.                                                      |        |
| Renumbered TPCs and Figures                                                                         | Global |
| Deletion of 14-Lead Cerdip and 14-Lead PDIP information                                             | Global |
| Changes to FEATURES                                                                                 | 1      |
| Changes to PIN CONNECTIONS                                                                          | 1      |
| Changes to ABSOLUTE MAXIMUM RATINGS                                                                 | 2      |
| Changes to ORDERING GUIDE                                                                           | 2      |
| Changes to ELECTRICAL CHARACTERISTICS                                                               | 3      |
| Removal of DICE CHARACTERISTICS, WAFER TEST LIMITS, and TYPICAL ELECTRICAL CHARACTERISTICS sections | 4      |
| Changes to TPCs 2, 5, and 6                                                                         | 4      |
| Updated OUTLINE DIMENSIONS                                                                          | 8      |





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