

**查询"LT1013CDRE4"供应商**

- **Single-Supply Operation**
  - Input Voltage Range Extends to Ground
  - Output Swings to Ground While Sinking Current
- **Input Offset Voltage**
  - 150  $\mu\text{V}$  Max at 25°C for LT1013A
- **Offset-Voltage Temperature Coefficient**
  - 2.5  $\mu\text{V}/^\circ\text{C}$  Max for LT1013A
- **Input Offset Current**
  - 0.8 nA Max at 25°C for LT1013A
- **High Gain . . . 1.5 V/ $\mu\text{V}$  Min ( $R_L = 2 \text{ k}\Omega$ ), 0.8 V/ $\mu\text{V}$  Min ( $R_L = 600 \text{ k}\Omega$ ) for LT1013A**
- **Low Supply Current . . . 0.5 mA Max at  $T_A = 25^\circ\text{C}$  for LT1013A**
- **Low Peak-to-Peak Noise Voltage . . . 0.55  $\mu\text{V}$  Typ**
- **Low Current Noise . . . 0.07 pA/ $\sqrt{\text{Hz}}$  Typ**

The LT1013 devices are dual precision operational amplifiers, featuring high gain, low supply current, low noise, and low-offset-voltage temperature coefficient.

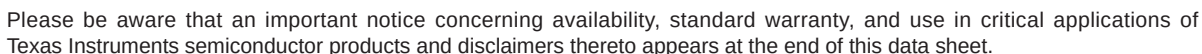
The LT1013 devices can be operated from a single 5-V power supply; the common-mode input voltage range includes ground, and the output can also swing to within a few millivolts of ground. Crossover distortion is eliminated. The LT1013 can be operated with both dual  $\pm 15\text{-V}$  and single 5-V supplies.

The LT1013C, LT1013AC, and LT1013D are characterized for operation from 0°C to 70°C. The LT1013I, LT1013AI, and LT1013DI are characterized for operation from -40°C to 105°C. The LT1013M, LT1013AM, and LT1013DM are characterized for operation over the full military temperature range of -55°C to 125°C.

| Pin | Function |
|-----|----------|
| 1   | 1IN+     |
| 2   | VCC-     |
| 3   | 2IN+     |
| 4   | 2IN-     |
| 5   | 1IN-     |
| 6   | 1OUT     |
| 7   | VCC+     |
| 8   | 2OUT     |

NC – No internal connection

Pinout diagram of the ADXL045 digital accelerometer. The chip is shown with pins 1 through 8. Pin 1 is labeled 1OUT, pin 2 is 1IN-, pin 3 is 1IN+, and pin 4 is VCC-. Pin 8 is VCC+, pin 7 is 2OUT, pin 6 is 2IN-, and pin 5 is 2IN+.



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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

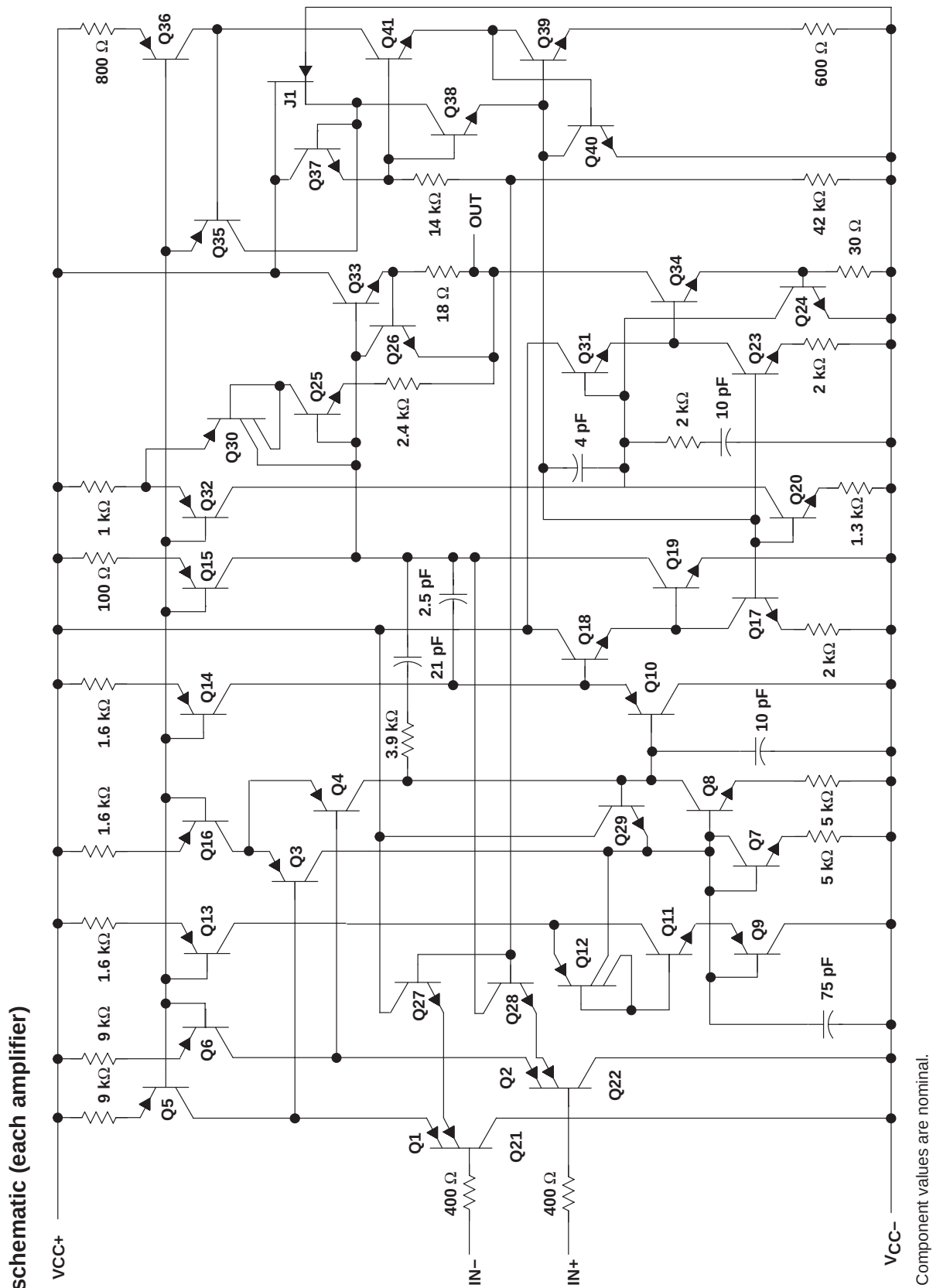
SLOS029B MAY 1993 (REVISED) OCTOBER 2004

本文件为LT1013CDRE的中文翻译

## ORDERING INFORMATION

| T <sub>A</sub> | V <sub>IO</sub> max<br>AT 25°C<br>(μV) | PACKAGE†    |              | ORDERABLE<br>PART NUMBER | TOP-SIDE<br>MARKING |
|----------------|----------------------------------------|-------------|--------------|--------------------------|---------------------|
| 0°C to 70°C    | 300                                    | P-DIP (P)   | Tube of 50   | LT1013CP                 | LT1013P             |
|                |                                        | SOIC (D)    | Tube of 75   | LT1013CD                 | 1013C               |
|                |                                        |             | Reel of 2500 | LT1013CDR                |                     |
|                | 800                                    | P-DIP (P)   | Tube of 50   | LT1013DP                 | LT1013DP            |
|                |                                        | SOIC (D)    | Tube of 75   | LT1013DD                 | 1013D               |
|                |                                        |             | Reel of 2500 | LT1013DDR                |                     |
| -40°C to 105°C | 800                                    | P-DIP (P)   | Tube of 50   | LT1013DIP                | LT1013DIP           |
|                |                                        | SOIC (D)    | Tube of 75   | LT1013DID                | 1013DI              |
|                |                                        |             | Reel of 2500 | LT1013DIDR               |                     |
| -55°C to 125°C | 150                                    | C-DIP (JG)  | Tube of 50   | LT1013AMJG               | LT1013AMJG          |
|                |                                        | C-DIP (JGB) | Tube of 50   | LT1013AMJGB              | LT1013AMJGB         |
|                |                                        | LCCC (FK)   | Tube of 55   | LT1013AMFK               | LT1013AMFK          |
|                |                                        | LCCC (FKB)  | Tube of 55   | LT1013AMFKB              | LT1013AMFKB         |
|                | 300                                    | C-DIP (JG)  | Tube of 50   | LT1013MJG                | LT1013MJG           |
|                |                                        | C-DIP (JGB) | Tube of 50   | LT1013MJGB               | LT1013MJGB          |
|                |                                        | LCCC (FKB)  | Tube of 55   | LT1013MFKB               | LT1013MFKB          |
|                | 800                                    | SOIC (D)    | Tube of 75   | LT1013DMD                | 1013DM              |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



LT1013, LT1013A, LT1013D  
DUAL PRECISION OPERATIONAL AMPLIFIERS

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted) †

|                                                                          |                                     |
|--------------------------------------------------------------------------|-------------------------------------|
| Supply voltage (see Note 1): $V_{CC+}$                                   | 22 V                                |
| $V_{CC-}$                                                                | -22 V                               |
| Input voltage range, $V_I$ (any input, see Note 1)                       | $V_{CC-} - 5\text{ V}$ to $V_{CC+}$ |
| Differential input voltage (see Note 2)                                  | $\pm 30\text{ V}$                   |
| Duration of short-circuit current at (or below) 25°C (see Note 3)        | Unlimited                           |
| Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5): D package  | 97°C/W                              |
| P package                                                                | 85°C/W                              |
| Operating virtual junction temperature, $T_J$                            | 150°C                               |
| Case temperature for 60 seconds: FK package                              | 260°C                               |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: JG package | 300°C                               |
| Storage temperature range, $T_{stg}$                                     | -65°C to 150°C                      |

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES:
1. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
  2. Differential voltages are at  $IN+$  with respect to  $IN-$ .
  3. The output may be shorted to either supply.
  4. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability. Due to variation in individual device electrical characteristics and thermal resistance, the built-in thermal overload protection may be activated at power levels slightly above or below the rated dissipation.
  5. The package thermal impedance is calculated in accordance with JESD 51-7.



# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

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electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $V_{IC} = 0$  (unless otherwise noted)

| PARAMETER                                                                  | TEST CONDITIONS                                    | $T_A^\dagger$ | LT1013C    |                     |      | LT1013AC   |                     |      | LT1013DC   |                     |      | UNIT                         |
|----------------------------------------------------------------------------|----------------------------------------------------|---------------|------------|---------------------|------|------------|---------------------|------|------------|---------------------|------|------------------------------|
|                                                                            |                                                    |               | MIN        | TYP <sup>‡</sup>    | MAX  | MIN        | TYP <sup>‡</sup>    | MAX  | MIN        | TYP <sup>‡</sup>    | MAX  |                              |
| $V_{IO}$ Input offset voltage                                              | $R_S = 50\ \Omega$                                 | 25°C          |            | 60                  | 300  |            | 40                  | 150  |            | 200                 | 800  | $\mu\text{V}$                |
|                                                                            |                                                    | Full range    |            |                     | 400  |            |                     | 240  |            |                     | 1000 |                              |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage          |                                                    | Full range    |            | 0.4                 | 2.5  |            | 0.3                 | 2    |            | 0.7                 | 5    | $\mu\text{V}/^\circ\text{C}$ |
| Long-term drift of input offset voltage                                    |                                                    | 25°C          |            | 0.5                 |      |            | 0.4                 |      |            | 0.5                 |      | $\mu\text{V}/\text{mo}$      |
| $I_{IO}$ Input offset current                                              |                                                    | 25°C          |            | 0.2                 | 1.5  |            | 0.15                | 0.8  |            | 0.2                 | 1.5  | nA                           |
|                                                                            |                                                    | Full range    |            |                     | 2.8  |            |                     | 1.5  |            |                     | 2.8  |                              |
| $I_{IB}$ Input bias current                                                |                                                    | 25°C          |            | -15                 | -30  |            | -12                 | -20  |            | -15                 | -30  | nA                           |
|                                                                            |                                                    | Full range    |            |                     | -38  |            |                     | -25  |            |                     | -38  |                              |
| $V_{ICR}$ Common-mode input voltage range                                  |                                                    | 25°C          | -15        | -15.3<br>to<br>13.5 | 13.8 | -15        | -15.3<br>to<br>13.5 | 13.8 | -15        | -15.3<br>to<br>13.5 | 13.8 | V                            |
|                                                                            |                                                    | Full range    | -15        | -15<br>to<br>13     |      | -15        | -15<br>to<br>13     |      | -15        | -15<br>to<br>13     |      |                              |
| $V_{OM}$ Maximum peak output voltage swing                                 | $R_L = 2\text{ k}\Omega$                           | 25°C          | $\pm 12.5$ | $\pm 14$            |      | $\pm 13$   | $\pm 14$            |      | $\pm 12.5$ | $\pm 14$            |      | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                   | $V_O = \pm 10\text{ V}$ , $R_L = 600\ \Omega$      | Full range    | $\pm 12$   |                     |      | $\pm 12.5$ |                     |      | $\pm 12$   |                     |      | V/ $\mu\text{V}$             |
|                                                                            | $V_O = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$ | 25°C          | 0.5        | 0.2                 |      | 0.8        | 2.5                 |      | 0.5        | 2                   |      |                              |
|                                                                            |                                                    | 25°C          | 1.2        | 7                   |      | 1.5        | 8                   |      | 1.2        | 7                   |      |                              |
| CMRR Common-mode rejection ratio                                           | $V_{IC} = -15\text{ V}$ to $13.5\text{ V}$         | Full range    | 0.7        |                     |      | 1          |                     |      | 0.7        |                     |      | dB                           |
|                                                                            | $V_{IC} = -14.9\text{ V}$ to $13\text{ V}$         | 25°C          | 97         | 114                 |      | 100        | 117                 |      | 97         | 114                 |      |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ ) | $V_{CC+} = \pm 2\text{ V}$ to $\pm 18\text{ V}$    | Full range    | 94         |                     |      | 98         |                     |      | 94         |                     |      | dB                           |
|                                                                            |                                                    | 25°C          | 100        | 117                 |      | 103        | 120                 |      | 100        | 117                 |      |                              |
| Channel separation                                                         | $V_O = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$ | Full range    | 97         |                     |      | 101        |                     |      | 97         |                     |      | dB                           |
| Differential input resistance                                              |                                                    | 25°C          | 120        | 137                 |      | 123        | 140                 |      | 120        | 137                 |      | dB                           |
| $r_{ic}$ Common-mode input resistance                                      |                                                    | 25°C          | 70         | 300                 |      | 100        | 400                 |      | 70         | 300                 |      | $\text{M}\Omega$             |
|                                                                            |                                                    | 25°C          | 4          |                     |      | 5          |                     |      | 4          |                     |      |                              |
| $I_{CC}$ Supply current per amplifier                                      |                                                    | 25°C          | 0.35       | 0.55                |      | 0.35       | 0.5                 |      | 0.35       | 0.55                |      | mA                           |
|                                                                            |                                                    | Full range    |            | 0.7                 |      |            | 0.55                |      |            | 0.6                 |      |                              |

<sup>†</sup> Full range is 0°C to 70°C.  
<sup>‡</sup> All typical values are at  $T_A = 25^\circ\text{C}$ .



# LT1013, LT1013A, LT1013D

## DUAL PRECISION OPERATIONAL AMPLIFIERS

SPICE SH-1 MAY 1998 Datasheet Change NUMBER 2004

electrical characteristics at specified free-air temperature,  $V_{CC+} = 5\text{ V}$ ,  $V_{CC-} = 0$ ,  $V_O = 1.4\text{ V}$ ,  $V_{IC} = 0$  (unless otherwise noted)

| PARAMETER                                                | TEST CONDITIONS                                           | $T_A^\dagger$ | LT1013C |                  | LT1013AC |      | LT1013DC         |          | UNIT                   |
|----------------------------------------------------------|-----------------------------------------------------------|---------------|---------|------------------|----------|------|------------------|----------|------------------------|
|                                                          |                                                           |               | MIN     | TYP <sup>‡</sup> | MAX      | MIN  | TYP <sup>‡</sup> | MAX      |                        |
| $V_{IO}$ Input offset voltage                            | $R_S = 50\ \Omega$                                        | 25°C          | 90      | 450              | 250      | 60   | 250              | 950      | $\mu\text{V}$          |
|                                                          |                                                           | Full range    |         | 570              | 350      |      |                  | 1200     |                        |
| $I_{IO}$ Input offset current                            |                                                           | 25°C          | 0.3     | 2                | 1.3      | 0.2  | 0.3              | 2        | nA                     |
|                                                          |                                                           | Full range    |         | 6                | 3.5      |      |                  | 6        |                        |
| $I_{IB}$ Input bias current                              |                                                           | 25°C          | -18     | -50              | -35      | -15  | -18              | -50      | nA                     |
|                                                          |                                                           | Full range    |         | -90              | -55      |      |                  | -90      |                        |
| $V_{ICR}$ Common-mode input voltage range                |                                                           | 25°C          | 0       | -0.3 to 3.5      | 0 to 3.8 | 0    | -0.3 to 3.5      | 0 to 3.8 | V                      |
|                                                          |                                                           | Full range    | 0       | to 3             | to 3     | 0    | to 3             | to 3     |                        |
| $V_{OM}$ Maximum peak output voltage swing               | Output low, No load                                       | 25°C          | 15      | 25               | 15       | 25   | 15               | 25       | mV                     |
|                                                          | Output low, $R_L = 600\ \Omega$ to GND                    | 25°C          | 5       | 10               | 5        | 10   | 5                | 10       |                        |
|                                                          | Output low, $I_{\text{sink}} = 1\text{ mA}$               | Full range    |         | 13               |          | 13   |                  | 13       |                        |
|                                                          | Output high, No load                                      | 25°C          | 220     | 350              | 220      | 350  | 220              | 350      |                        |
|                                                          | Output high, $R_L = 600\ \Omega$ to GND                   | 25°C          | 4       | 4.4              | 4        | 4.4  | 4                | 4.4      |                        |
| $A_{VD}$ Large-signal differential voltage amplification | $V_O = 5\text{ mV}$ to $4\text{ V}$ , $R_L = 500\ \Omega$ | 25°C          | 3.4     | 4                | 3.4      | 4    | 3.4              | 4        | V                      |
|                                                          |                                                           | Full range    | 3.2     |                  | 3.3      |      | 3.2              |          |                        |
| $I_{CC}$ Supply current per amplifier                    |                                                           | 25°C          | 1       |                  | 1        |      | 1                |          | $\text{V}/\mu\text{V}$ |
|                                                          |                                                           | Full range    | 0.32    | 0.5              | 0.31     | 0.45 | 0.32             | 0.5      |                        |
|                                                          |                                                           |               |         | 0.55             |          | 0.5  |                  | 0.55     | mA                     |

<sup>†</sup> Full range is 0°C to 70°C.

<sup>‡</sup> All typical values are at  $T_A = 25^\circ\text{C}$ .

operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $V_{IC} = 0$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER                                               |  | TEST CONDITIONS |                                       | MIN |  | TYP  |  | MAX |  | UNIT                         |
|---------------------------------------------------------|--|-----------------|---------------------------------------|-----|--|------|--|-----|--|------------------------------|
| $S_R$ Slew rate                                         |  |                 |                                       | 0.2 |  | 0.4  |  |     |  | $\text{V}/\mu\text{s}$       |
| $V_n$ Equivalent input noise voltage                    |  |                 | $f = 10\text{ Hz}$                    |     |  | 24   |  |     |  | $\text{nV}/\sqrt{\text{Hz}}$ |
|                                                         |  |                 | $f = 1\text{ kHz}$                    |     |  | 22   |  |     |  |                              |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage |  |                 | $f = 0.1\text{ Hz}$ to $10\text{ Hz}$ |     |  | 0.55 |  |     |  | $\mu\text{V}$                |
| $I_n$ Equivalent input noise current                    |  |                 | $f = 10\text{ Hz}$                    |     |  | 0.07 |  |     |  | $\text{pA}/\sqrt{\text{Hz}}$ |



# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

查询"LT1013CDRE4"供应商

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electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $V_{IC} = 0$  (unless otherwise noted)

| PARAMETER                                                                  | TEST CONDITIONS                                    | $T_A^\dagger$ | LT1013I     |                  |     | LT1013AI    |                  |     | LT1013DI    |                  |      | UNIT                         |
|----------------------------------------------------------------------------|----------------------------------------------------|---------------|-------------|------------------|-----|-------------|------------------|-----|-------------|------------------|------|------------------------------|
|                                                                            |                                                    |               | MIN         | TYP <sup>‡</sup> | MAX | MIN         | TYP <sup>‡</sup> | MAX | MIN         | TYP <sup>‡</sup> | MAX  |                              |
| $V_{IO}$ Input offset voltage                                              | $R_S = 50\ \Omega$                                 | 25°C          | 60          |                  | 300 | 40          |                  | 150 | 200         |                  | 800  | $\mu\text{V}$                |
|                                                                            |                                                    | Full range    |             |                  | 550 |             |                  | 300 |             |                  | 1000 |                              |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage          |                                                    | Full range    | 0.4         |                  | 2.5 | 0.3         |                  | 2   | 0.7         |                  | 5    | $\mu\text{V}/^\circ\text{C}$ |
| Long-term drift of input offset voltage                                    |                                                    | 25°C          | 0.5         |                  |     | 0.4         |                  |     | 0.5         |                  |      | $\mu\text{V}/\text{mo}$      |
| $I_{IO}$ Input offset current                                              |                                                    | 25°C          | 0.2         |                  | 1.5 | 0.15        |                  | 0.8 | 0.2         |                  | 1.5  | nA                           |
|                                                                            |                                                    | Full range    |             |                  | 2.8 |             |                  | 1.5 |             |                  | 2.8  |                              |
| $I_{IB}$ Input bias current                                                |                                                    | 25°C          | -15         |                  | -30 | -12         |                  | -20 | -15         |                  | -30  | nA                           |
|                                                                            |                                                    | Full range    |             |                  | -38 |             |                  | -25 |             |                  | -38  |                              |
| $V_{ICR}$ Common-mode input voltage range                                  |                                                    | 25°C          | -15 to 13.5 | -15.3 to 13.8    |     | -15 to 13.5 | -15.3 to 13.8    |     | -15 to 13.5 | -15.3 to 13.8    |      | V                            |
|                                                                            |                                                    | Full range    | -15 to 13   |                  |     | -15 to 13   |                  |     | -15 to 13   |                  |      |                              |
| $V_{OM}$ Maximum peak output voltage swing                                 | $R_L = 2\text{ k}\Omega$                           | 25°C          | $\pm 12.5$  | $\pm 14$         |     | $\pm 13$    | $\pm 14$         |     | $\pm 12.5$  | $\pm 14$         |      | V                            |
|                                                                            |                                                    | Full range    | $\pm 12$    |                  |     | $\pm 12.5$  |                  |     | $\pm 12$    |                  |      |                              |
| $A_{VD}$ Large-signal differential voltage amplification                   | $V_O = \pm 10\text{ V}$ , $R_L = 600\ \Omega$      | 25°C          | 0.5         | 0.2              |     | 0.8         | 2.5              |     | 0.5         | 2                |      |                              |
|                                                                            | $V_O = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$ | 25°C          | 1.2         | 7                |     | 1.5         | 8                |     | 1.2         | 7                |      | $\text{V}/\mu\text{V}$       |
|                                                                            |                                                    | Full range    | 0.7         |                  |     | 1           |                  |     | 0.7         |                  |      |                              |
| CMRR Common-mode rejection ratio                                           | $V_{IC} = -15\text{ V to } 13.5\text{ V}$          | 25°C          | 97          | 114              |     | 100         | 117              |     | 97          | 114              |      | dB                           |
|                                                                            | $V_{IC} = -14.9\text{ V to } 13\text{ V}$          | Full range    | 94          |                  |     | 97          |                  |     | 94          |                  |      |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2\text{ V to } \pm 18\text{ V}$   | 25°C          | 100         | 117              |     | 103         | 120              |     | 100         | 117              |      | dB                           |
|                                                                            |                                                    | Full range    | 97          |                  |     | 101         |                  |     | 97          |                  |      |                              |
| Channel separation                                                         | $V_O = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$ | 25°C          | 120         | 137              |     | 123         | 140              |     | 120         | 137              |      | dB                           |
| $r_{id}$ Differential input resistance                                     |                                                    | 25°C          | 70          | 300              |     | 100         | 400              |     | 70          | 300              |      | M $\Omega$                   |
| $r_{ic}$ Common-mode input resistance                                      |                                                    | 25°C          | 4           |                  |     | 5           |                  |     | 4           |                  |      | G $\Omega$                   |
| $I_{CC}$ Supply current per amplifier                                      |                                                    | 25°C          | 0.35        | 0.55             |     | 0.35        | 0.5              |     | 0.35        | 0.55             |      | mA                           |
|                                                                            |                                                    | Full range    |             | 0.7              |     |             | 0.55             |     |             | 0.6              |      |                              |

<sup>†</sup> Full range is  $-40^\circ\text{C to } 105^\circ\text{C}$ .

<sup>‡</sup> All typical values are at  $T_A = 25^\circ\text{C}$ .



# LT1013, LT1013A, LT1013D

## DUAL PRECISION OPERATIONAL AMPLIFIERS

SPICE SH-1 MAY 1998 Datasheet Change NUMBER 2004

electrical characteristics at specified free-air temperature,  $V_{CC+} = 5\text{ V}$ ,  $V_{CC-} = 0$ ,  $V_O = 1.4\text{ V}$ ,  $V_{IC} = 0$  (unless otherwise noted)

| PARAMETER                                                | TEST CONDITIONS                                         | $T_A^\dagger$ | LT1013I  |                  |      | LT1013AI |                  |     | LT1013DI |                  |      | UNIT             |
|----------------------------------------------------------|---------------------------------------------------------|---------------|----------|------------------|------|----------|------------------|-----|----------|------------------|------|------------------|
|                                                          |                                                         |               | MIN      | TYP <sup>‡</sup> | MAX  | MIN      | TYP <sup>‡</sup> | MAX | MIN      | TYP <sup>‡</sup> | MAX  |                  |
| $V_{IO}$ Input offset voltage                            | $R_S = 50\ \Omega$                                      | 25°C          | 90       | 450              | 450  | 60       | 250              | 250 | 250      | 950              | 950  | $\mu\text{V}$    |
|                                                          |                                                         | Full range    |          | 570              | 570  |          | 350              | 350 |          | 1200             | 1200 |                  |
| $I_{IO}$ Input offset current                            |                                                         | 25°C          | 0.3      | 2                | 2    | 0.2      | 1.3              | 1.3 | 0.3      | 2                | 2    | nA               |
|                                                          |                                                         | Full range    |          | 6                | 6    |          | 3.5              | 3.5 |          | 6                | 6    |                  |
| $I_{IB}$ Input bias current                              |                                                         | 25°C          | -18      | -50              | -50  | -15      | -35              | -35 | -18      | -50              | -50  | nA               |
|                                                          |                                                         | Full range    |          | -90              | -90  |          | -55              | -55 |          | -90              | -90  |                  |
| $V_{ICR}$ Common-mode input voltage range                |                                                         | 25°C          | 0        | -0.3             |      | 0        | -0.3             |     | 0        | -0.3             |      | V                |
|                                                          |                                                         | Full range    | 0 to 3.5 | 3.8 to 3.5       |      | 0 to 3.5 | 3.8 to 3.5       |     | 0 to 3.5 | 3.8 to 3.5       |      |                  |
| $V_{OM}$ Maximum peak output voltage swing               | Output low, No load                                     | 25°C          | 15       | 25               | 25   | 15       | 25               | 25  | 15       | 25               | 25   | mV               |
|                                                          |                                                         | Full range    | 5        | 10               | 10   | 5        | 10               | 10  | 5        | 10               | 10   |                  |
|                                                          | Output low, $R_L = 600\ \Omega$ to GND                  | 25°C          |          | 13               | 13   |          | 13               | 13  |          | 13               | 13   |                  |
|                                                          |                                                         | Full range    |          | 220              | 350  |          | 220              | 350 |          | 220              | 350  |                  |
|                                                          | Output high, No load                                    | 25°C          | 4        | 4.4              | 4.4  | 4        | 4.4              | 4.4 | 4        | 4.4              | 4.4  |                  |
|                                                          |                                                         | Full range    | 3.4      | 4                | 4    | 3.4      | 4                | 4   | 3.4      | 4                | 4    |                  |
| $A_{VD}$ Large-signal differential voltage amplification | $V_O = 5\text{ mV to }4\text{ V}$ , $R_L = 500\ \Omega$ | 25°C          | 1        |                  |      | 1        |                  |     | 1        |                  |      | V/ $\mu\text{V}$ |
|                                                          |                                                         | Full range    | 0.32     | 0.5              | 0.55 | 0.31     | 0.45             | 0.5 | 0.32     | 0.5              | 0.55 |                  |
| $I_{CC}$ Supply current per amplifier                    |                                                         | 25°C          |          |                  |      |          |                  |     |          |                  |      | mA               |
|                                                          |                                                         | Full range    |          |                  |      |          |                  |     |          |                  |      |                  |

<sup>†</sup> Full range is -40°C to 105°C.

<sup>‡</sup> All typical values are at  $T_A = 25^\circ\text{C}$ .

operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $V_{IC} = 0$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER   |                                             |  |  | TEST CONDITIONS |  |  |                     | MIN TYP MAX |      |  |  | UNIT                   |
|-------------|---------------------------------------------|--|--|-----------------|--|--|---------------------|-------------|------|--|--|------------------------|
| SR          | Slew rate                                   |  |  |                 |  |  |                     | 0.2         | 0.4  |  |  | V/ $\mu\text{s}$       |
|             |                                             |  |  |                 |  |  |                     |             |      |  |  |                        |
| $V_n$       | Equivalent input noise voltage              |  |  |                 |  |  | f = 10 Hz           |             | 24   |  |  | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             |  |  |                 |  |  |                     |             |      |  |  |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage |  |  |                 |  |  | f = 1 kHz           |             | 22   |  |  | $\mu\text{V}$          |
|             |                                             |  |  |                 |  |  |                     |             |      |  |  |                        |
| $I_n$       | Equivalent input noise current              |  |  |                 |  |  | f = 0.1 Hz to 10 Hz |             | 0.55 |  |  | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             |  |  |                 |  |  |                     |             |      |  |  |                        |



# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

查询"LT1013CDRE4"供应商

SLOS018H – MAY 1988 – REVISED NOVEMBER 2004

electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $V_{IC} = 0$  (unless otherwise noted)

| PARAMETER                                                                  | TEST CONDITIONS                                    | $T_A^\dagger$ | LT1013M     |                  |     | LT1013AM    |                  |     | LT1013DM    |                  |     | UNIT                         |
|----------------------------------------------------------------------------|----------------------------------------------------|---------------|-------------|------------------|-----|-------------|------------------|-----|-------------|------------------|-----|------------------------------|
|                                                                            |                                                    |               | MIN         | TYP <sup>‡</sup> | MAX | MIN         | TYP <sup>‡</sup> | MAX | MIN         | TYP <sup>‡</sup> | MAX |                              |
| $V_{IO}$ Input offset voltage                                              | $R_S = 50\ \Omega$                                 | 25°C          | 60          | 300              |     | 40          | 150              |     | 200         | 800              |     | $\mu\text{V}$                |
|                                                                            |                                                    | Full range    |             | 550              |     |             | 300              |     |             | 1000             |     |                              |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage          |                                                    | Full range    | 0.5         | 2.5*             |     | 0.4         | 2*               |     | 0.5         | 2.5*             |     | $\mu\text{V}/^\circ\text{C}$ |
| Long-term drift of input offset voltage                                    |                                                    | 25°C          | 0.5         |                  |     | 0.4         |                  |     | 0.5         |                  |     | $\mu\text{V}/\text{mo}$      |
| $I_{IO}$ Input offset current                                              |                                                    | 25°C          | 0.2         | 1.5              |     | 0.15        | 0.8              |     | 0.2         | 1.5              |     | nA                           |
|                                                                            |                                                    | Full range    |             | 5                |     |             | 2.5              |     |             | 5                |     |                              |
| $I_{IB}$ Input bias current                                                |                                                    | 25°C          | -15         | -30              |     | -12         | -20              |     | -15         | -30              |     | nA                           |
|                                                                            |                                                    | Full range    |             | -45              |     |             | -30              |     |             | -45              |     |                              |
| $V_{ICR}$ Common-mode input voltage range                                  |                                                    | 25°C          | -15 to 13.5 | -15.3 to 13.8    |     | -15 to 13.5 | -15.3 to 13.8    |     | -15 to 13.5 | -15.3 to 13.8    |     | V                            |
|                                                                            |                                                    | Full range    | -14.9 to 13 |                  |     | -14.9 to 13 |                  |     | -14.9 to 13 |                  |     |                              |
| $V_{OM}$ Maximum peak output voltage swing                                 | $R_L = 2\text{ k}\Omega$                           | 25°C          | $\pm 12.5$  | $\pm 14$         |     | $\pm 13$    | $\pm 14$         |     | $\pm 12.5$  | $\pm 14$         |     | V                            |
|                                                                            |                                                    | Full range    | $\pm 11.5$  |                  |     | $\pm 12$    |                  |     | $\pm 11.5$  |                  |     |                              |
| $A_{VD}$ Large-signal differential voltage amplification                   | $V_O = \pm 10\text{ V}$ , $R_L = 600\ \Omega$      | 25°C          | 0.5         | 2                |     | 0.8         | 2.5              |     | 0.5         | 2                |     | $\text{V}/\mu\text{V}$       |
|                                                                            | $V_O = +10\text{ V}$ , $R_L = 2\text{ k}\Omega$    | 25°C          | 1.2         | 7                |     | 1.5         | 8                |     | 1.2         | 7                |     |                              |
|                                                                            |                                                    | Full range    | 0.25        |                  |     | 0.5         |                  |     | 0.25        |                  |     |                              |
| $CMRR$ Common-mode rejection ratio                                         | $V_{IC} = -15\text{ V}$ to $13.5\text{ V}$         | 25°C          | 97          | 117              |     | 100         | 117              |     | 97          | 114              |     | dB                           |
|                                                                            | $V_{IC} = -14.9\text{ V}$ to $13\text{ V}$         | Full range    | 94          |                  |     | 97          |                  |     | 94          |                  |     |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2\text{ V}$ to $\pm 18\text{ V}$  | 25°C          | 100         | 117              |     | 103         | 120              |     | 100         | 117              |     | dB                           |
|                                                                            |                                                    | Full range    | 97          |                  |     | 100         |                  |     | 97          |                  |     |                              |
| Channel separation                                                         | $V_O = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$ | 25°C          | 120         | 137              |     | 123         | 140              |     | 120         | 137              |     | dB                           |
| Differential input resistance                                              |                                                    | 25°C          | 70          | 300              |     | 100         | 400              |     | 70          | 300              |     | $\text{M}\Omega$             |
| Common-mode input resistance                                               |                                                    | 25°C          | 4           |                  |     | 5           |                  |     | 4           |                  |     | $\text{G}\Omega$             |
| $I_{CC}$ Supply current per amplifier                                      |                                                    | 25°C          | 0.35        | 0.55             |     | 0.35        | 0.5              |     | 0.35        | 0.55             |     | mA                           |
|                                                                            |                                                    | Full range    |             | 0.7              |     |             | 0.6              |     |             | 0.7              |     |                              |

\* On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C.

‡ All typical values are at  $T_A = 25^\circ\text{C}$ .



# LT1013, LT1013A, LT1013D

## DUAL PRECISION OPERATIONAL AMPLIFIERS

SYNOPSIS: MAY 1978, REVISED NOVEMBER 2004

中文资料: LT1013CDR 中文资料

electrical characteristics at specified free-air temperature,  $V_{CC+} = 5\text{ V}$ ,  $V_{CC-} = 0$ ,  $V_O = 1.4\text{ V}$ ,  $V_{IC} = 0$  (unless otherwise noted)

| PARAMETER                                                | TEST CONDITIONS                                           | $T_A^\dagger$ | LT1013M |                  |        | LT1013AM |                  |        | LT1013DM |                  |        | UNIT          |
|----------------------------------------------------------|-----------------------------------------------------------|---------------|---------|------------------|--------|----------|------------------|--------|----------|------------------|--------|---------------|
|                                                          |                                                           |               | MIN     | TYP <sup>‡</sup> | MAX    | MIN      | TYP <sup>‡</sup> | MAX    | MIN      | TYP <sup>‡</sup> | MAX    |               |
| $V_{IO}$ Input offset voltage                            | $R_S = 50\ \Omega$                                        | 25°C          | 90      | 450              | 450    | 60       | 250              | 250    | 250      | 950              | 950    | $\mu\text{V}$ |
|                                                          |                                                           | Full range    | 400     | 1500             | 1500   | 250      | 900              | 900    | 800      | 2000             | 2000   |               |
| $I_{IO}$ Input offset current                            | $R_S = 50\ \Omega$ , $V_{IC} = 0.1\text{ V}$              | 125°C         | 200     | 750              | 750    | 120      | 450              | 450    | 560      | 1200             | 1200   | nA            |
|                                                          |                                                           | 25°C          | 0.3     | 2                | 2      | 0.2      | 1.3              | 1.3    | 0.3      | 2                | 2      |               |
| $I_{IB}$ Input bias current                              |                                                           | Full range    |         | 10               | 10     |          | 6                | 6      |          | 10               | 10     | nA            |
|                                                          |                                                           | 25°C          | -18     | -50              | -50    | -15      | -35              | -35    | -18      | -50              | -50    |               |
| $V_{ICR}$ Common-mode input voltage range                |                                                           | Full range    |         | -120             | -120   |          | -80              | -80    |          | -120             | -120   | V             |
|                                                          |                                                           | 25°C          | 0       | -0.3             | to 3.5 | 0        | -0.3             | to 3.5 | 0        | -0.3             | to 3.8 |               |
| $V_{OM}$ Maximum peak output voltage swing               | Output low, No load                                       | Full range    | 0       | to 3             | to 3.8 | 0        | to 3             | to 3.8 | 0        | to 3             | to 3.8 | V             |
|                                                          |                                                           | 25°C          | 15      | 25               | 25     | 15       | 25               | 25     | 15       | 25               | 25     |               |
|                                                          |                                                           | 25°C          | 5       | 10               | 10     | 5        | 10               | 10     | 5        | 10               | 10     |               |
|                                                          | Output high, $R_L = 600\ \Omega$ to GND                   | Full range    |         | 18               | 18     |          | 15               | 15     |          | 18               | 18     | mV            |
|                                                          |                                                           | 25°C          | 220     | 350              | 350    | 220      | 350              | 350    | 220      | 350              | 350    |               |
|                                                          |                                                           | 25°C          | 4       | 4.4              | 4.4    | 4        | 4.4              | 4.4    | 4        | 4.4              | 4.4    |               |
| $A_{VD}$ Large-signal differential voltage amplification | Output high, $R_L = 600\ \Omega$ to GND                   | 25°C          | 3.4     | 4                | 4      | 3.4      | 4                | 4      | 3.4      | 4                | 4      | V             |
|                                                          |                                                           | Full range    | 3.1     |                  |        | 3.2      |                  |        | 3.1      |                  |        |               |
|                                                          |                                                           | 25°C          | 1       |                  |        | 1        |                  |        | 1        |                  |        |               |
| $I_{CC}$ Supply current per amplifier                    | $V_O = 5\text{ mV}$ to $4\text{ V}$ , $R_L = 500\ \Omega$ | 25°C          | 0.32    | 0.5              | 0.5    | 0.31     | 0.45             | 0.45   | 0.32     | 0.5              | 0.5    | mA            |
|                                                          |                                                           | Full range    |         | 0.65             | 0.65   |          | 0.55             | 0.55   |          | 0.65             | 0.65   |               |

<sup>†</sup> Full range is -55°C to 125°C.

<sup>‡</sup> All typical values are at  $T_A = 25^\circ\text{C}$ .

operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $V_{IC} = 0$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER   |                                             | TEST CONDITIONS                       |  | MIN | TYP  | MAX | UNIT                   |
|-------------|---------------------------------------------|---------------------------------------|--|-----|------|-----|------------------------|
| SR          | Slew rate                                   |                                       |  | 0.2 | 0.4  |     | V/ $\mu\text{s}$       |
| $V_n$       | Equivalent input noise voltage              | $f = 10\text{ Hz}$                    |  |     | 24   |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                    |  |     | 22   |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz}$ to $10\text{ Hz}$ |  |     | 0.55 |     | $\mu\text{V}$          |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                    |  |     | 0.07 |     | pA/ $\sqrt{\text{Hz}}$ |

## TYPICAL CHARACTERISTICS

Table of Graphs

|                 |                                    |                       | FIGURE     |
|-----------------|------------------------------------|-----------------------|------------|
| $V_{IO}$        | Input offset voltage               | vs Supply voltage     | 1          |
|                 |                                    | vs Temperature        | 2          |
| $\Delta V_{IO}$ | Change in input offset voltage     | vs Time               | 3          |
| $I_{IO}$        | Input offset current               | vs Temperature        | 4          |
| $I_{IB}$        | Input bias current                 | vs Temperature        | 5          |
| $V_{IC}$        | Common-mode input voltage          | vs Input bias current | 6          |
| $A_{VD}$        | Differential voltage amplification | vs Load resistance    | 7, 8       |
|                 |                                    | vs Frequency          | 9, 10      |
|                 | Channel separation                 | vs Frequency          | 11         |
|                 | Output saturation voltage          | vs Temperature        | 12         |
| CMRR            | Common-mode rejection ratio        | vs Frequency          | 13         |
| $k_{SVR}$       | Supply-voltage rejection ratio     | vs Frequency          | 14         |
| $I_{CC}$        | Supply current                     | vs Temperature        | 15         |
| $I_{OS}$        | Short-circuit output current       | vs Time               | 16         |
| $V_n$           | Equivalent input noise voltage     | vs Frequency          | 17         |
| $I_n$           | Equivalent input noise current     | vs Frequency          | 17         |
| $V_{N(PP)}$     | Peak-to-peak input noise voltage   | vs Time               | 18         |
|                 | Pulse response                     | Small signal          | 19, 21     |
|                 |                                    | Large signal          | 20, 22, 23 |
|                 | Phase shift                        | vs Frequency          | 9          |

# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

SLO0039 Rev. 1 MAY 1993 (REVISED NOVEMBER 2004)

## TYPICAL CHARACTERISTICS†

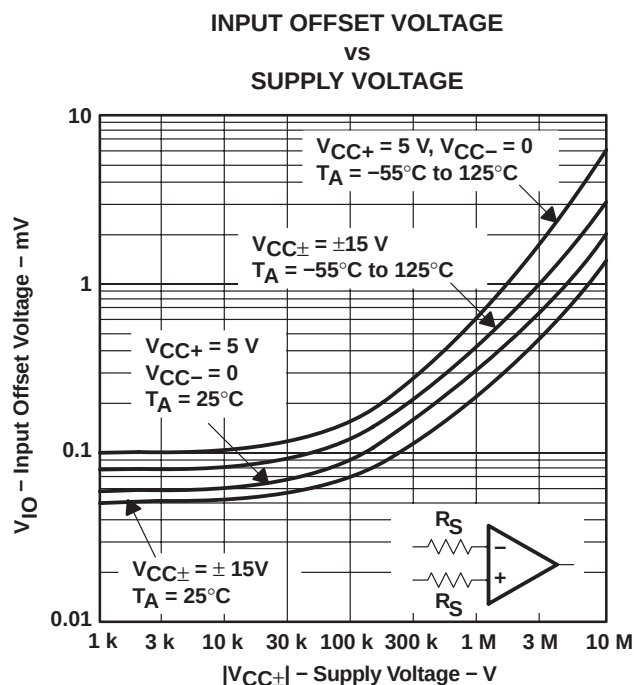


Figure 1

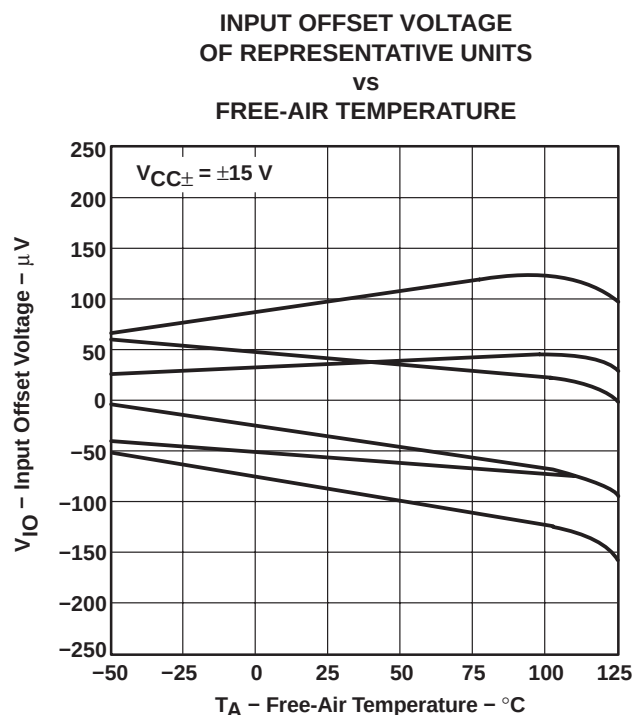


Figure 2

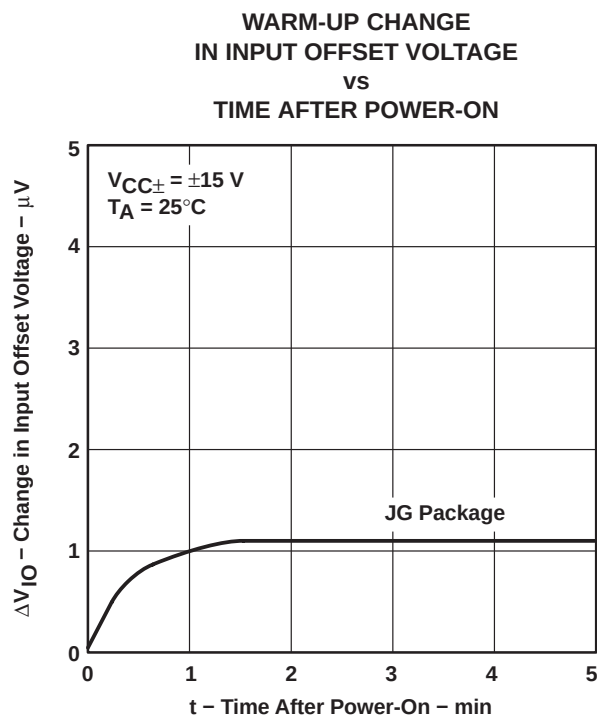


Figure 3

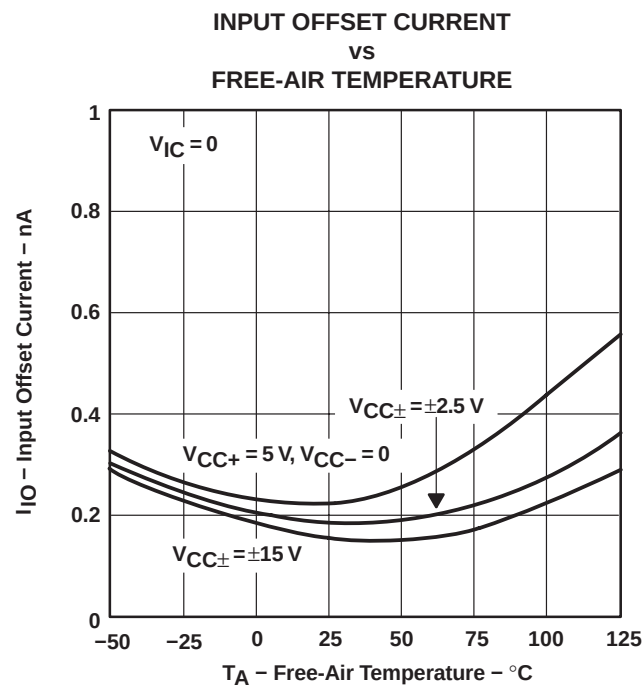


Figure 4

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

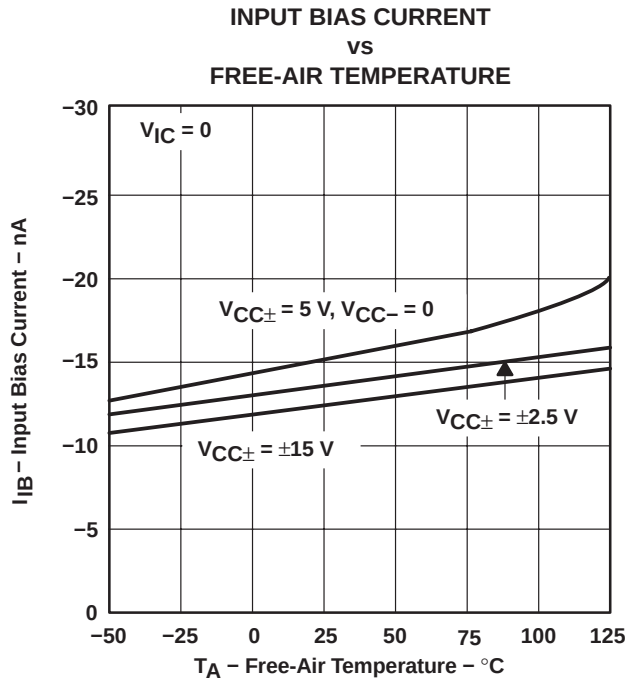


Figure 5

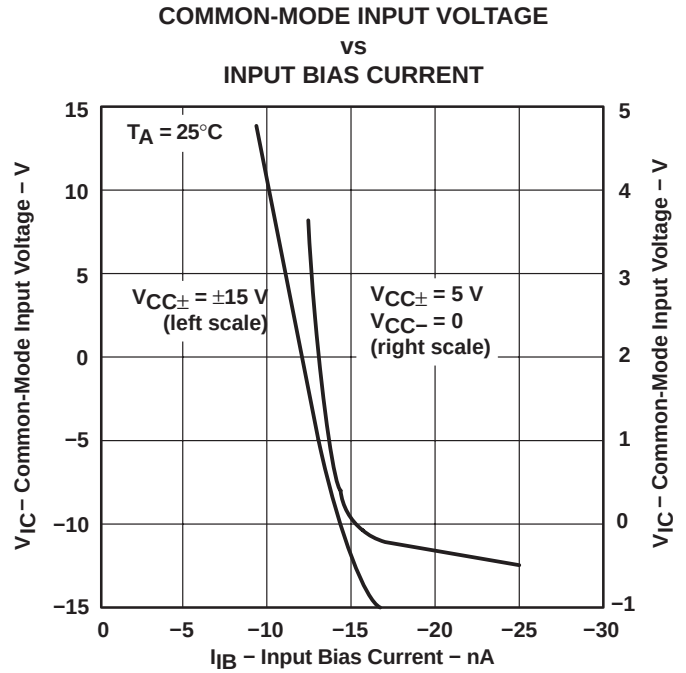


Figure 6

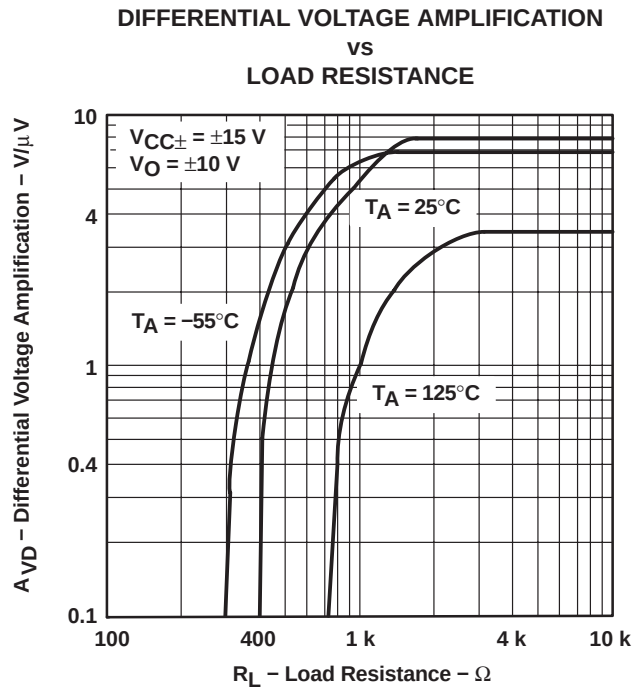


Figure 7

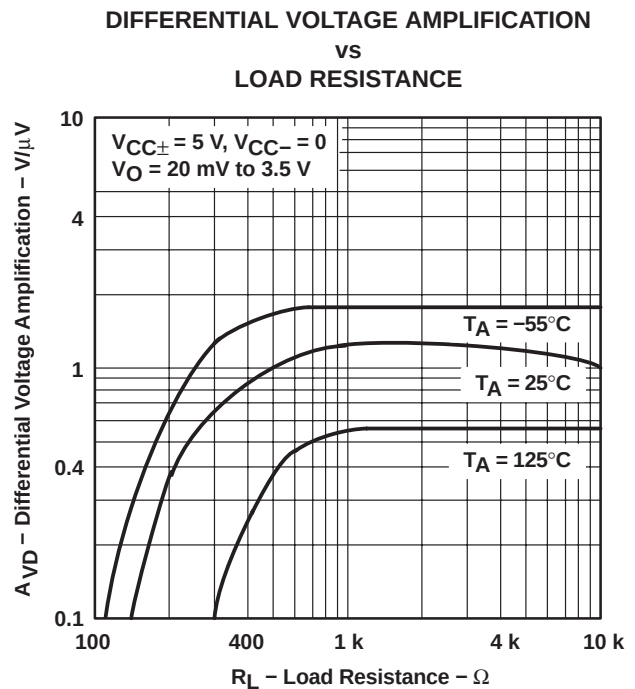


Figure 8

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

SLO00396 MAY 1993 (REVISED NOVEMBER 2004)

## TYPICAL CHARACTERISTICS†

DIFFERENTIAL VOLTAGE AMPLIFICATION  
AND PHASE SHIFT  
VS  
FREQUENCY

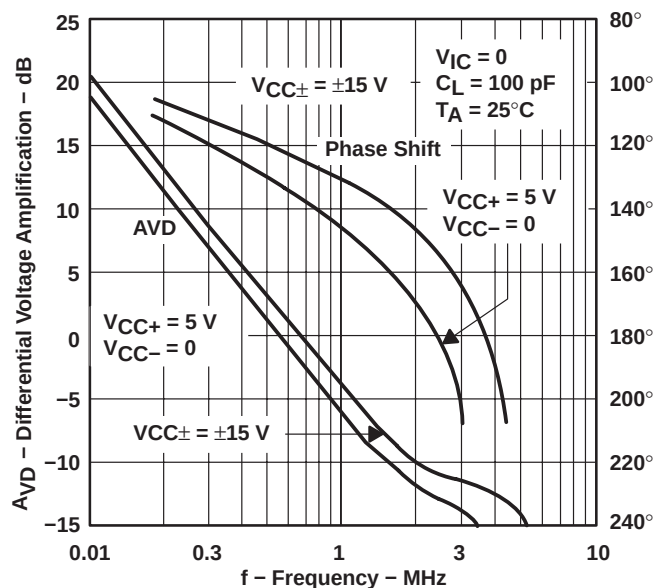


Figure 9

DIFFERENTIAL VOLTAGE AMPLIFICATION  
VS  
FREQUENCY

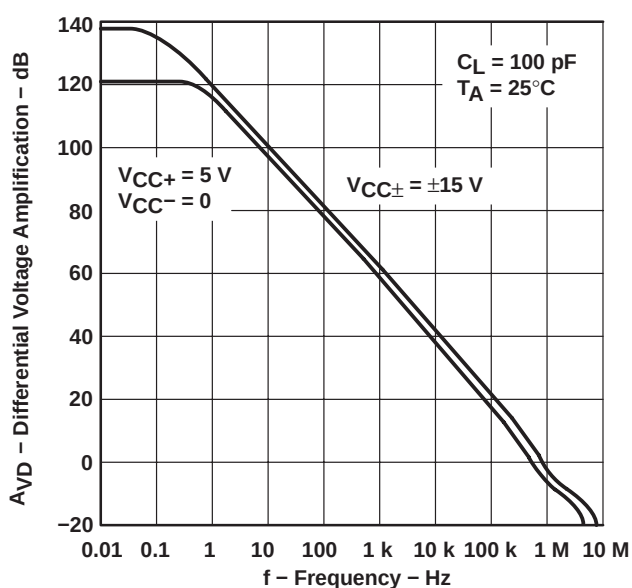


Figure 10

CHANNEL SEPARATION  
VS  
FREQUENCY

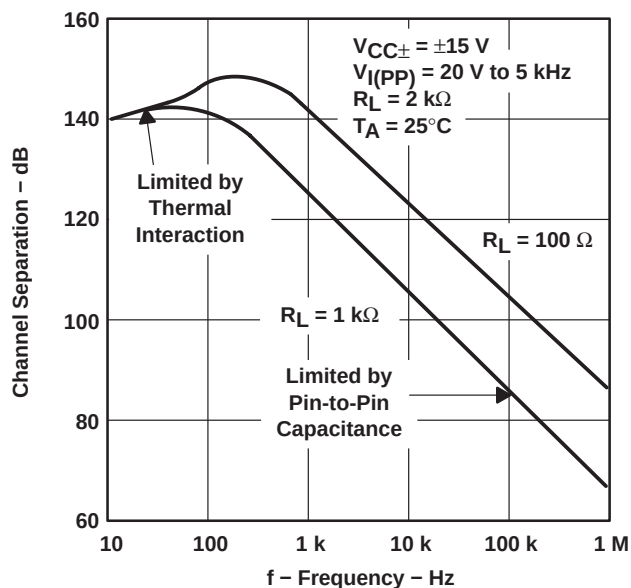


Figure 11

OUTPUT SATURATION VOLTAGE  
VS  
FREE-AIR TEMPERATURE

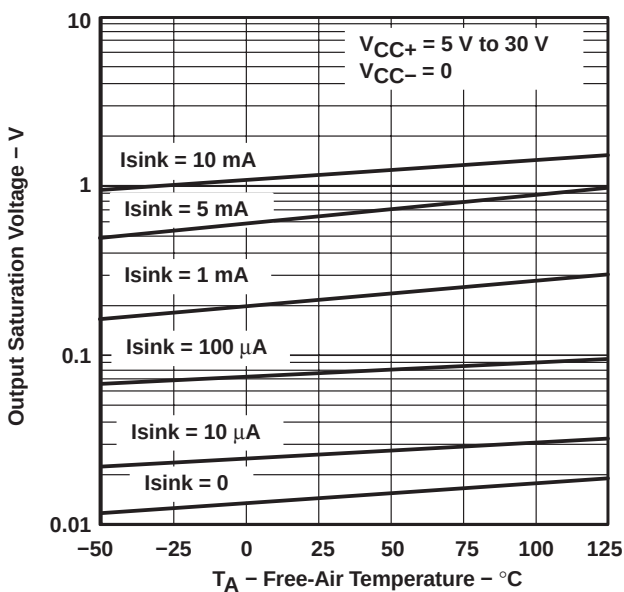


Figure 12

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

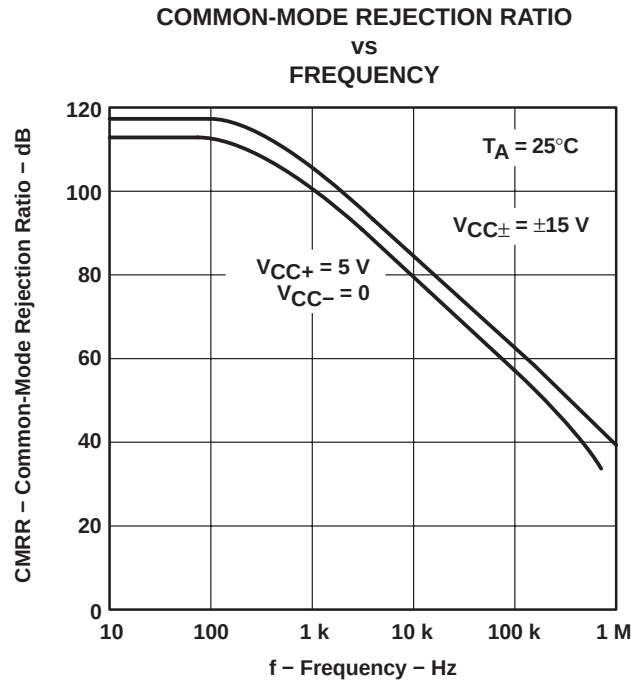


Figure 13

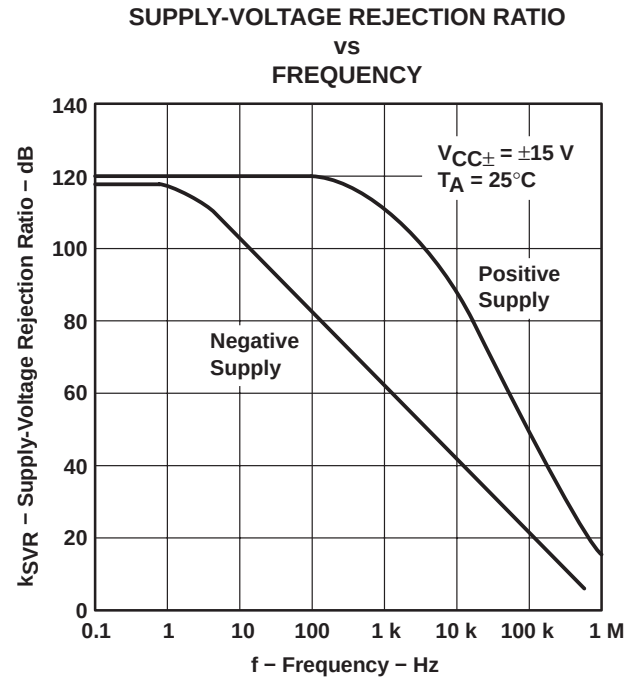


Figure 14

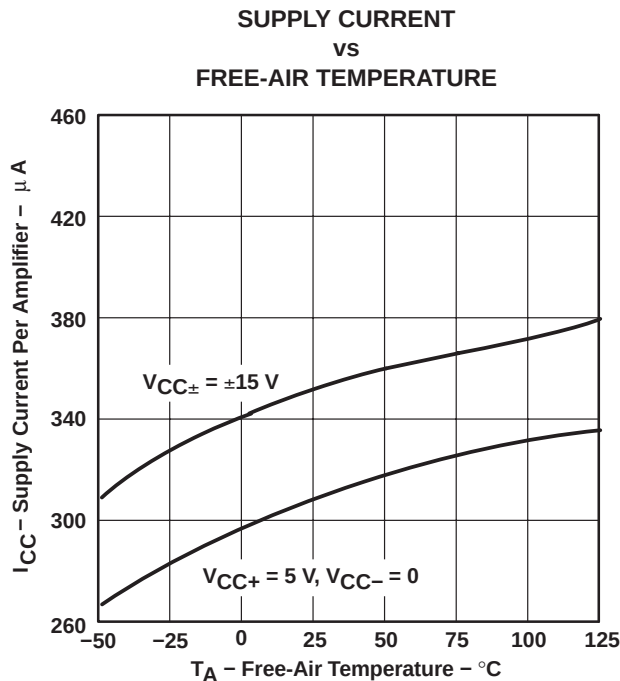


Figure 15

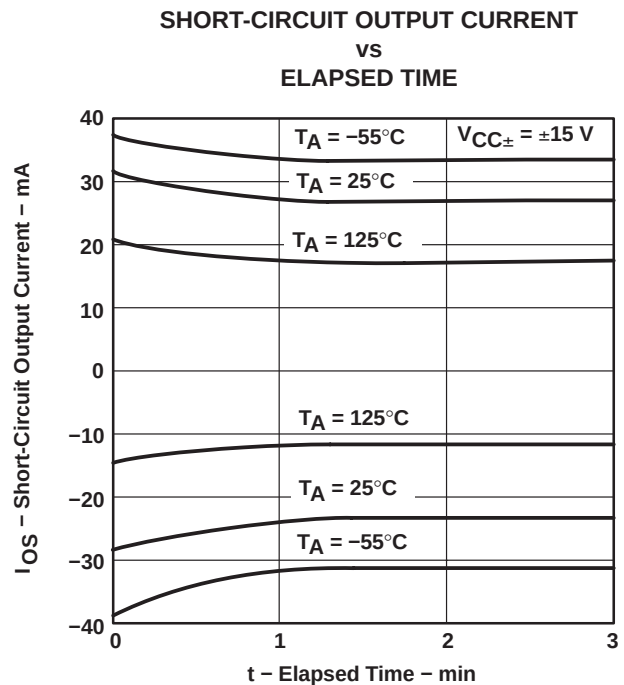


Figure 16

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

LT1013, LT1013A, LT1013D  
DUAL PRECISION OPERATIONAL AMPLIFIERS

SLO00396 MAY 1993 (REVISED) NOVEMBER 2004

TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE  
AND EQUIVALENT INPUT NOISE CURRENT  
VS  
FREQUENCY

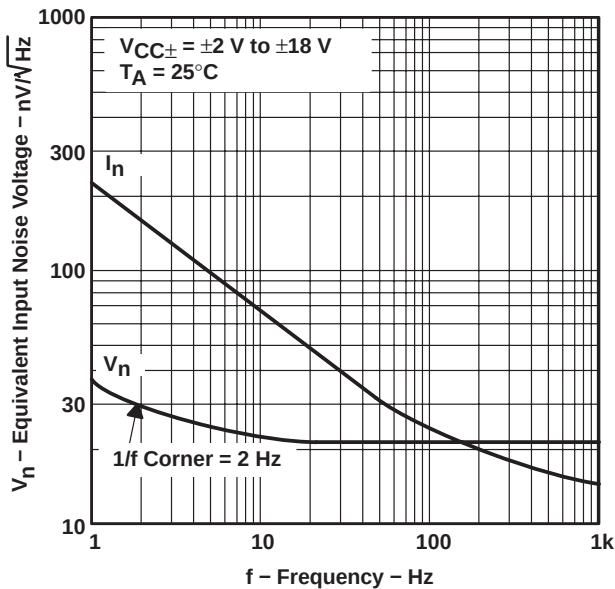


Figure 17

PEAK-TO-PEAK INPUT NOISE VOLTAGE  
OVER A  
10-SECOND PERIOD

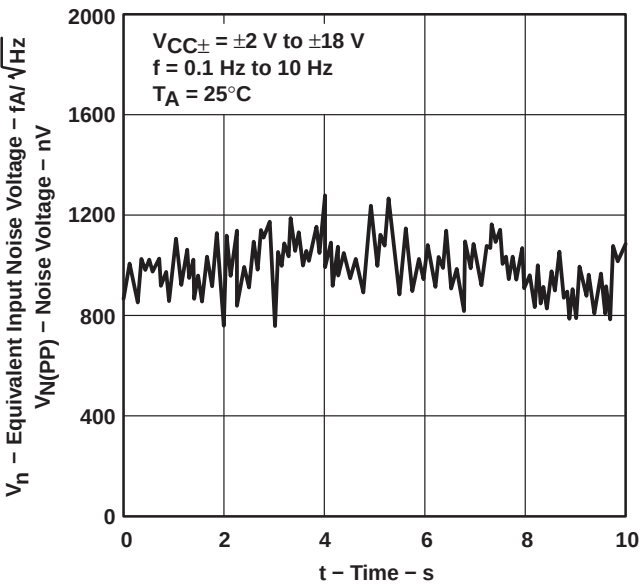


Figure 18

VOLTAGE-FOLLOWER  
SMALL-SIGNAL  
PULSE RESPONSE

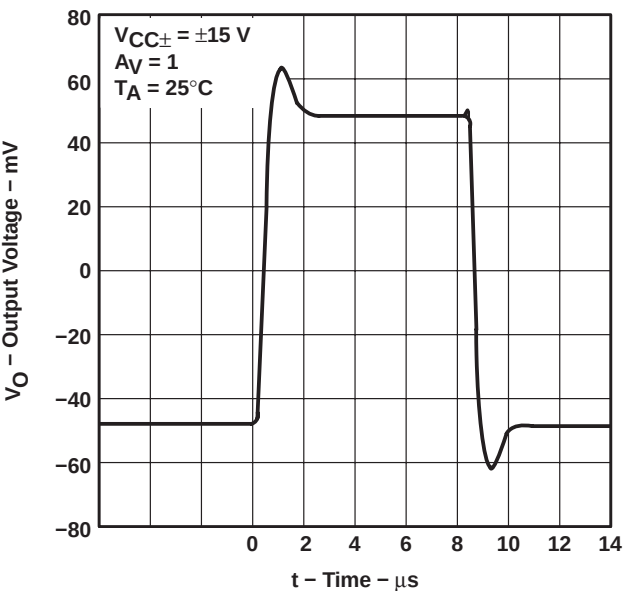


Figure 19

VOLTAGE-FOLLOWER  
LARGE-SIGNAL  
PULSE RESPONSE

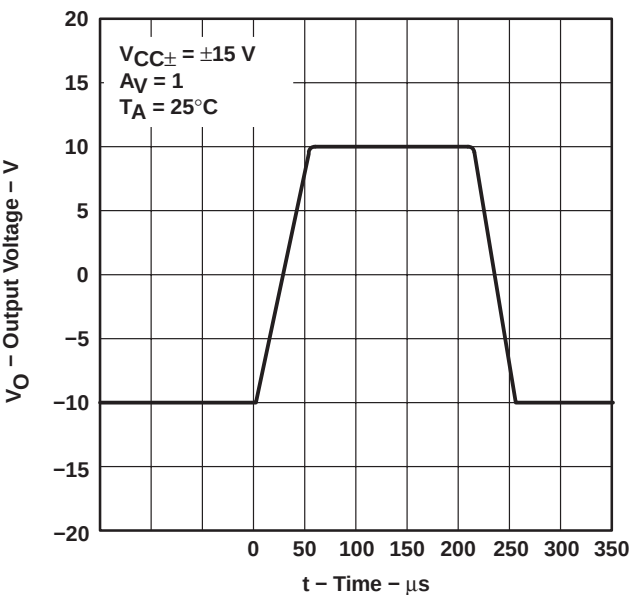


Figure 20



# TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER  
SMALL-SIGNAL  
PULSE RESPONSE

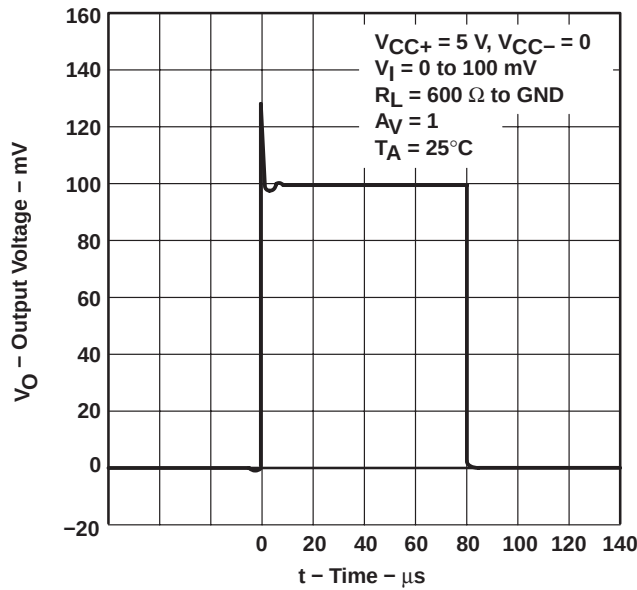


Figure 21

VOLTAGE-FOLLOWER  
LARGE-SIGNAL  
PULSE RESPONSE

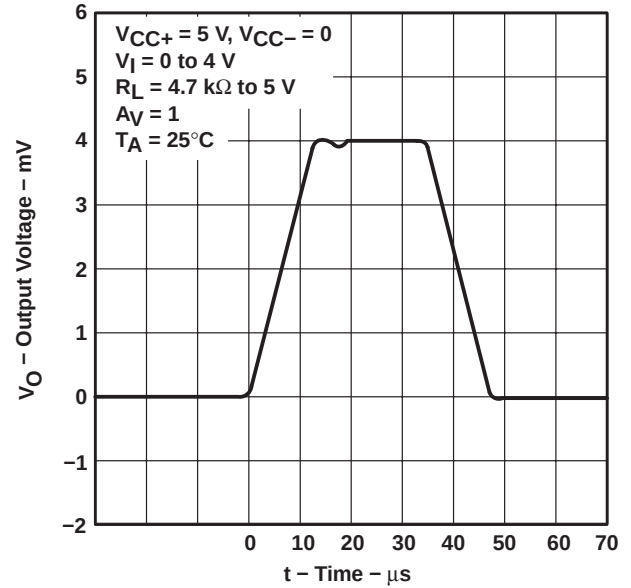


Figure 22

VOLTAGE-FOLLOWER  
LARGE-SIGNAL  
PULSE RESPONSE

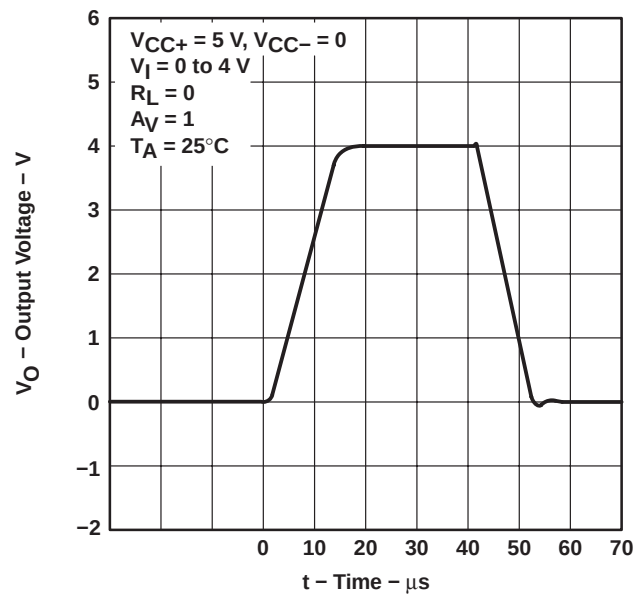


Figure 23

# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

SLO0039 Rev. 1 MAY 1993 (REVISED NOVEMBER 2004)

## APPLICATION INFORMATION

### single-supply operation

The LT1013 is fully specified for single-supply operation ( $V_{CC-} = 0$ ). The common-mode input voltage range includes ground, and the output swings to within a few millivolts of ground.

Furthermore, the LT1013 has specific circuitry that addresses the difficulties of single-supply operation, both at the input and at the output. At the input, the driving signal can fall below 0 V, either inadvertently or on a transient basis. If the input is more than a few hundred millivolts below ground, the LT1013 is designed to deal with the following two problems that can occur:

1. On many other operational amplifiers, when the input is more than a diode drop below ground, unlimited current flows from the substrate ( $V_{CC-}$  terminal) to the input, which can destroy the unit. On the LT1013, the 400- $\Omega$  resistors in series with the input [see *schematic (each amplifier)*] protect the device, even when the input is 5 V below ground.
2. When the input is more than 400 mV below ground (at  $T_A = 25^\circ\text{C}$ ), the input stage of similar operational amplifiers saturates, and phase reversal occurs at the output. This can cause lockup in servo systems. Because of unique phase-reversal protection circuitry (Q21, Q22, Q27, and Q28), the LT1013 outputs do not reverse, even when the inputs are at  $-1.5$  V (see Figure 24).

This phase-reversal protection circuitry does not function when the other operational amplifier on the LT1013 is driven hard into negative saturation at the output. Phase-reversal protection does not work on amplifier 1 when amplifier 2 output is in negative saturation nor on amplifier 2 when amplifier 1 output is in negative saturation.

At the output, other single-supply designs either cannot swing to within 600 mV of ground or cannot sink more than a few microamperes while swinging to ground. The all-npn output stage of the LT1013 maintains its low output resistance and high-gain characteristics until the output is saturated. In dual-supply operations, the output stage is free of crossover distortion.

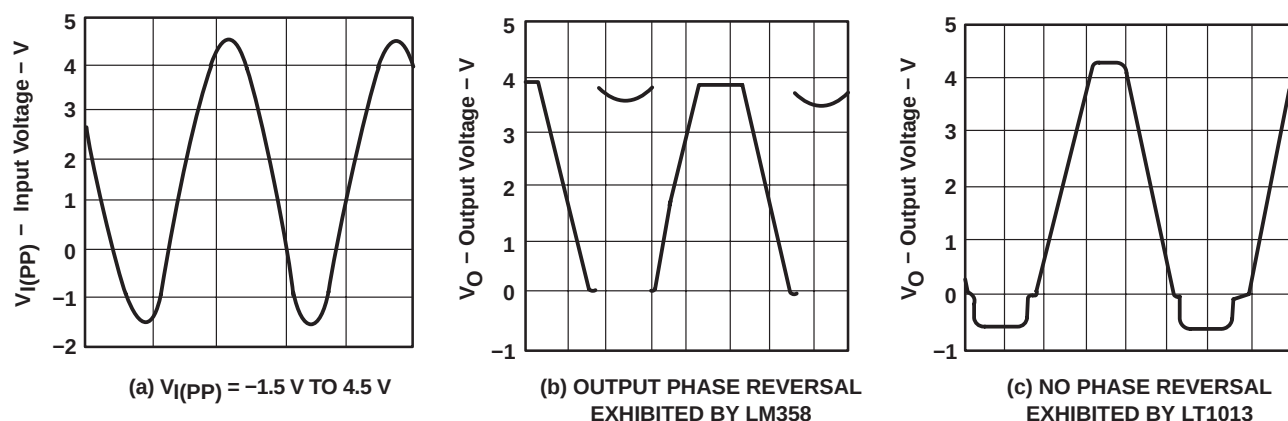


Figure 24. Voltage-Follower Response With Input Exceeding the Negative Common-Mode Input Voltage Range

## APPLICATION INFORMATION

### comparator applications

The single-supply operation of the LT1013 is well suited for use as a precision comparator with TTL-compatible output. In systems using both operational amplifiers and comparators, the LT1013 can perform multiple duties (see Figures 25 and 26).

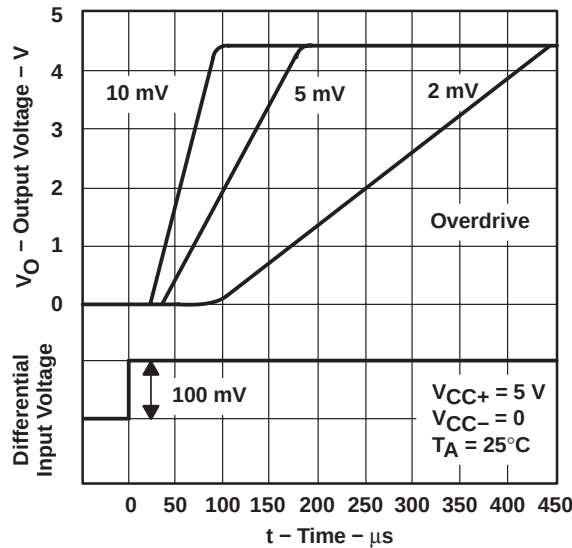


Figure 25. Low-to-High-Level Output Response for Various Input Overdrives

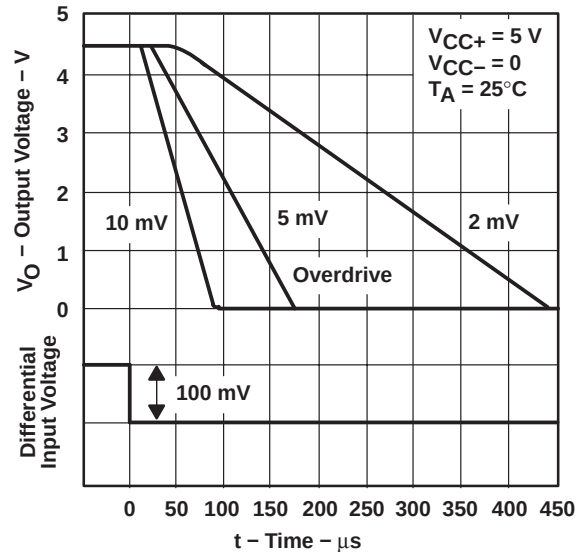


Figure 26. High-to-Low-Level Output Response for Various Input Overdrives

### low-supply operation

The minimum supply voltage for proper operation of the LT1013 is 3.4 V (three NiCad batteries). Typical supply current at this voltage is 290  $\mu$ A; therefore, power dissipation is only 1 mW per amplifier.

### offset voltage and noise testing

The test circuit for measuring input offset voltage and its temperature coefficient is shown in Figure 30. This circuit, with supply voltages increased to  $\pm 20$  V, also is used as the burn-in configuration.

The peak-to-peak equivalent input noise voltage of the LT1013 is measured using the test circuit shown in Figure 27. The frequency response of the noise tester indicates that the 0.1-Hz corner is defined by only one zero. The test time to measure 0.1-Hz to 10-Hz noise should not exceed 10 seconds, as this time limit acts as an additional zero to eliminate noise contribution from the frequency band below 0.1 Hz.

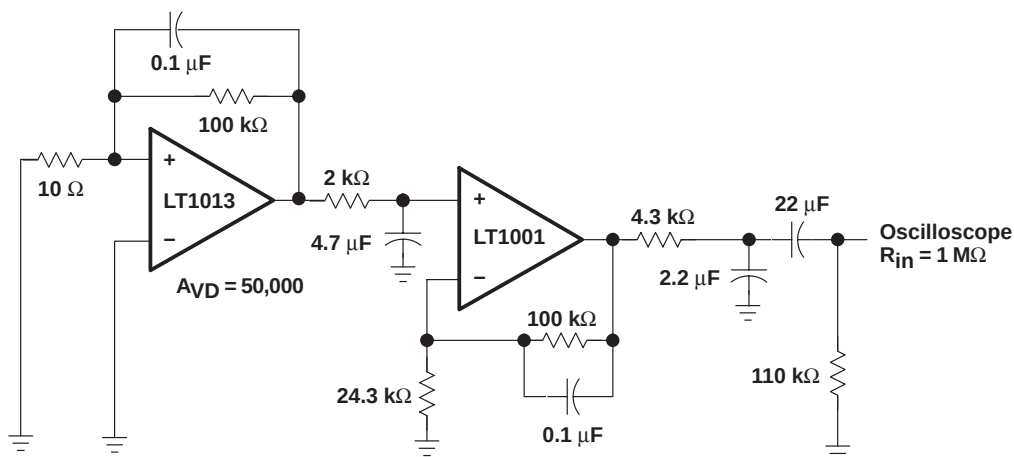
An input noise voltage test is recommended when measuring the noise of a large number of units. A 10-Hz input noise voltage measurement correlates well with a 0.1-Hz peak-to-peak noise reading because both results are determined by the white noise and the location of the  $1/f$  corner frequency.

Current noise is measured by the circuit and formula shown in Figure 28. The noise of the source resistors is subtracted.

# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

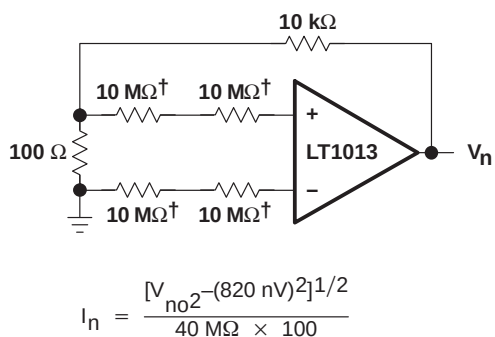
SLO00299c MAY 1993 (REVISED) L1013C, L1013D, L1013E 2004

## APPLICATION INFORMATION



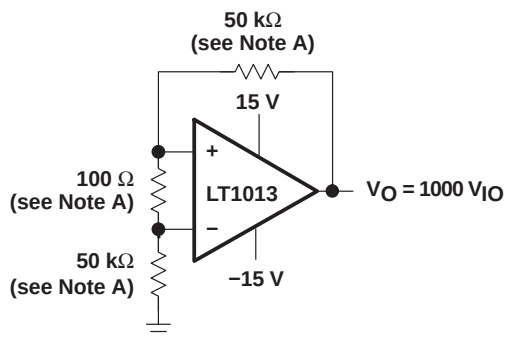
NOTE A: All capacitor values are for nonpolarized capacitors only.

Figure 27. 0.1-Hz to 10-Hz Peak-to-Peak Noise Test Circuit



† Metal-film resistor

Figure 28. Noise-Current Test Circuit and Formula



NOTE A: Resistors must have low thermoelectric potential.

Figure 29. Test Circuit for  $V_{IO}$  and  $\alpha_{V_{IO}}$

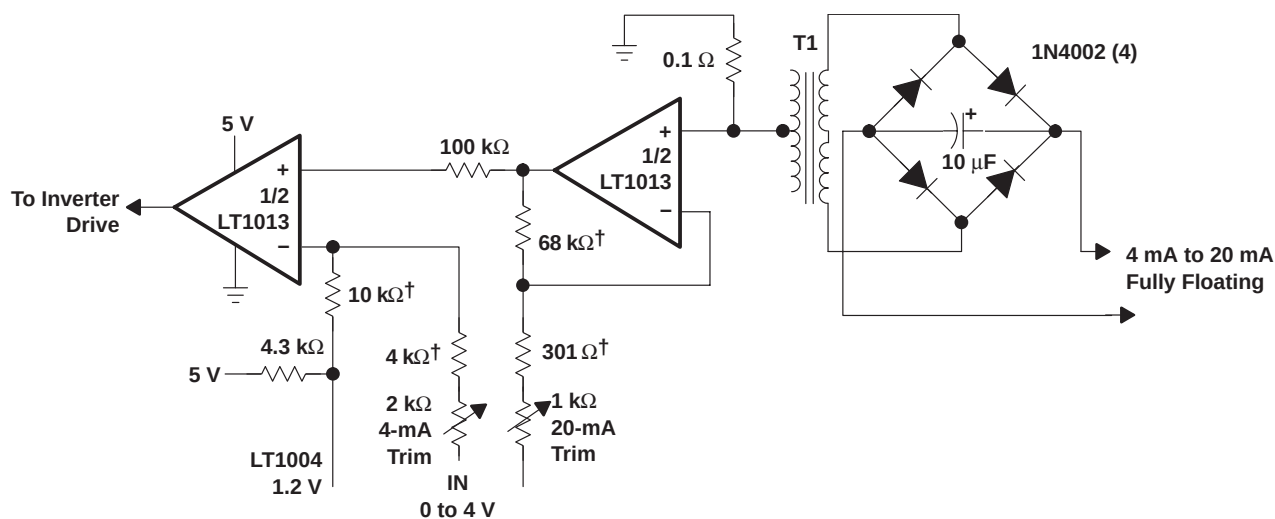
[illegible]

# LT1013, LT1013A, LT1013D DUAL PRECISION OPERATIONAL AMPLIFIERS

SLOS029B MAY 1993 (REVISED) NOVEMBER 2004

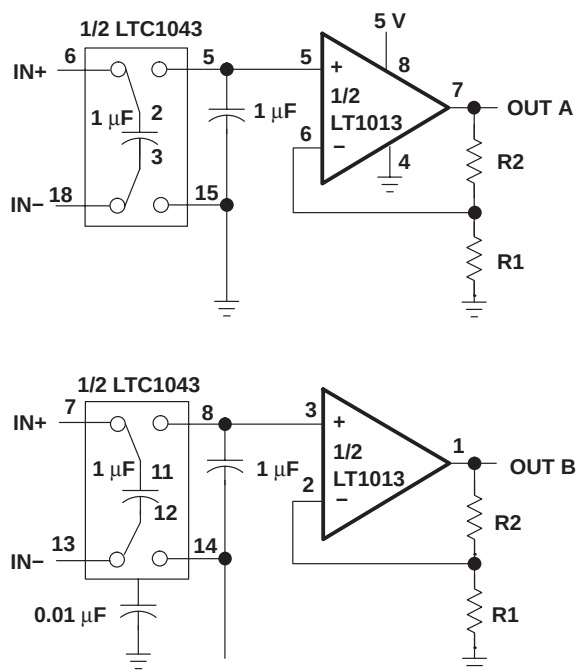
本海"LT1013DRE"供应商

## APPLICATION INFORMATION



† 1% film resistor

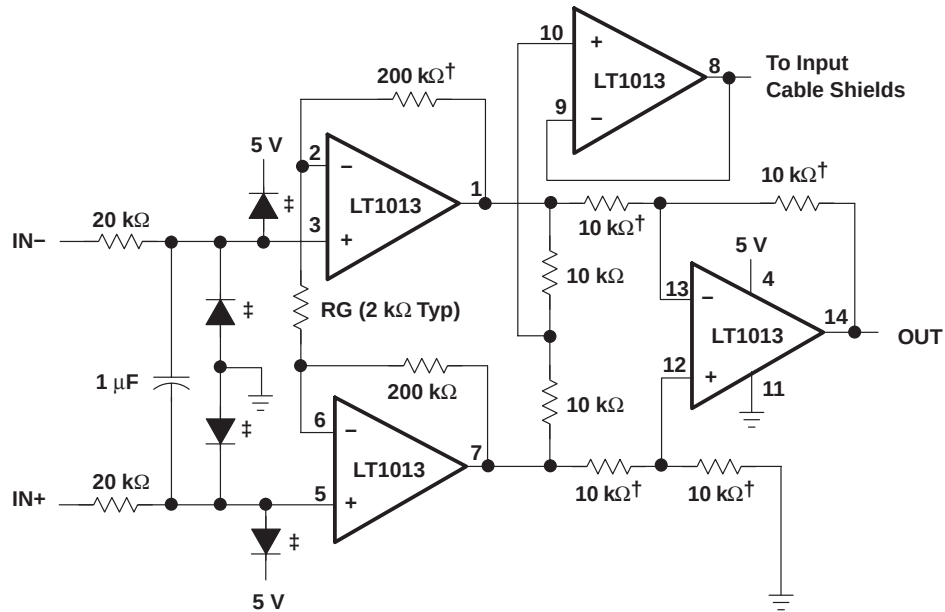
Figure 31. Fully Floating Modification to 4-mA to 20-mA Current-Loop Transmitter With 8-Bit Accuracy



NOTE A:  $V_{IO} = 150 \mu V$ ,  $A_{VD} = (R1/R2) + 1$ ,  $CMRR = 120 \text{ dB}$ ,  $V_{ICR} = 0 \text{ to } 5 \text{ V}$

Figure 32. 5-V Single-Supply Dual Instrumentation Amplifier

# APPLICATION INFORMATION



† 1% film resistor. Match 10-kΩ resistors to within 0.05%.

‡ For high source impedances, use 2N2222 diodes.

NOTE A:  $A_{VD} = (400,000/RG) + 1$

Figure 33. 5-V Precision Instrumentation Amplifier

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 5962-88760012A   | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | POST-PLATE       | N / A for Pkg Type           |
| 5962-8876001PA   | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| 5962-88760022A   | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | POST-PLATE       | N / A for Pkg Type           |
| 5962-8876002PA   | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| LT1013AMFKB      | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | POST-PLATE       | N / A for Pkg Type           |
| LT1013AMJG       | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| LT1013AMJGB      | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| LT1013AMP        | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                      |
| LT1013CD         | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013CDE4       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013CDG4       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013CDR        | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013CDRE4      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013CDRG4      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013CP         | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LT1013CPE4       | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LT1013DD         | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DDE4       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DDG4       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DDR        | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DDRE4      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DDRG4      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DID        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DIDE4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DIDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DIDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DIDRE4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DIDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |



| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LT1013DIP        | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LT1013DIPE4      | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LT1013DMD        | ACTIVE                | SOIC         | D               | 8    | 75          | TBD                     | CU NIPDAU        | Level-1-220C-UNLIM           |
| LT1013DMDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1013DP         | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LT1013DPE4       | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LT1013IP         | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                      |
| LT1013MFKB       | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | POST-PLATE       | N / A for Pkg Type           |
| LT1013MJG        | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| LT1013MJGB       | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| LT1013MP         | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                      |
| LT1013Y          | OBSOLETE              | XCEPT        | Y               | 0    |             | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

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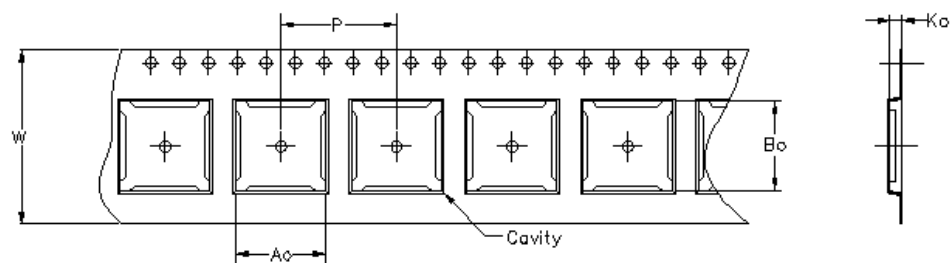
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

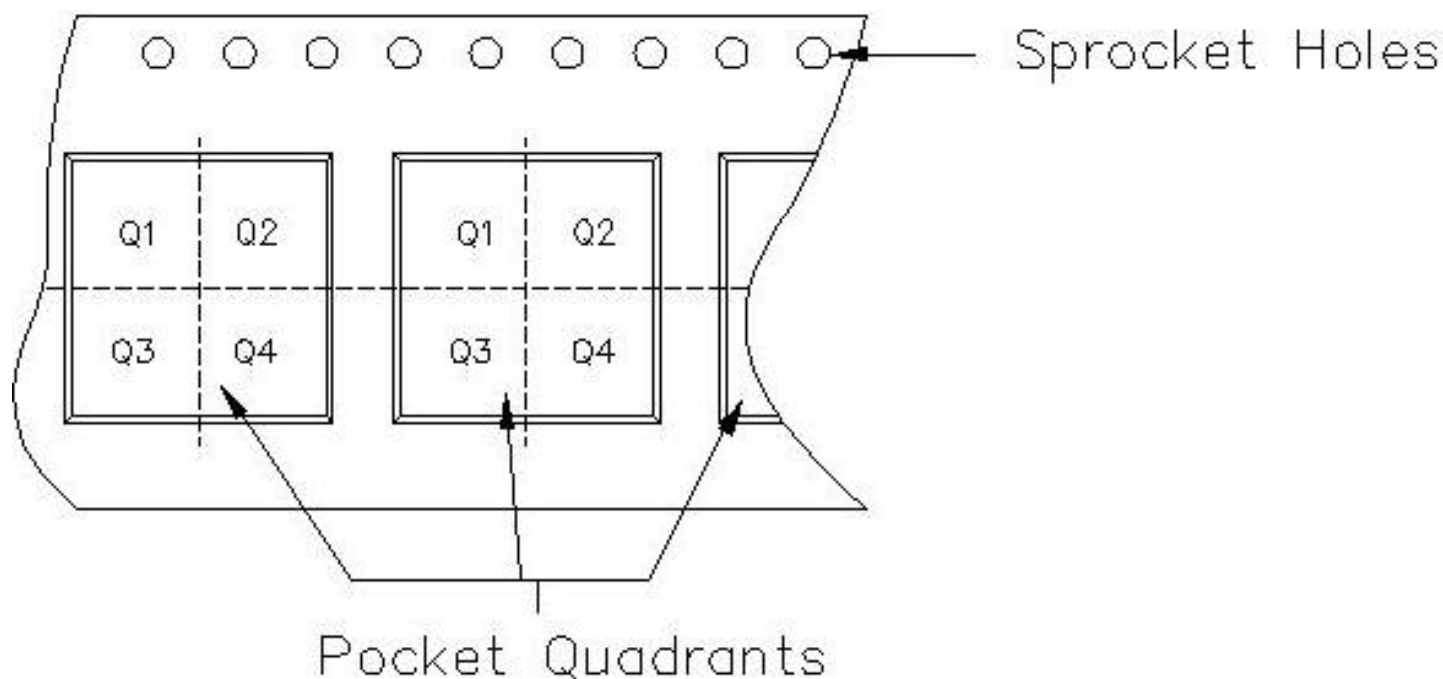
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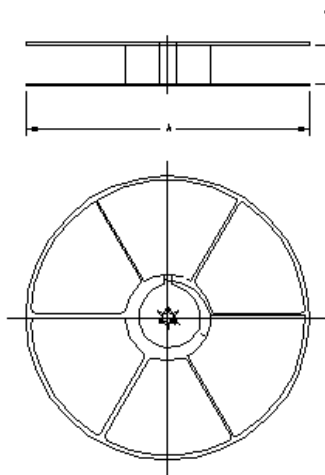
Carrier tape design is defined largely by the component length, width, and thickness.

|                                                                 |
|-----------------------------------------------------------------|
| A0 = Dimension designed to accommodate the component width.     |
| B0 = Dimension designed to accommodate the component length.    |
| K0 = Dimension designed to accommodate the component thickness. |
| W = Overall width of the carrier tape.                          |
| P = Pitch between successive cavity centers.                    |

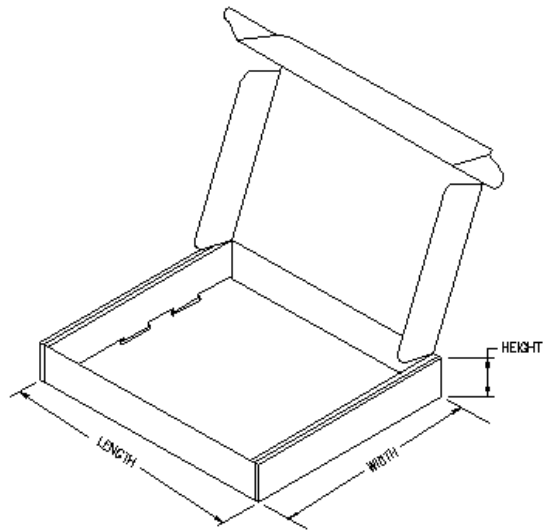


## TAPE AND REEL INFORMATION

| Device     | Package | Pins | Site | Reel<br>Diameter<br>(mm) | Reel<br>Width<br>(mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1<br>(mm) | W<br>(mm) | Pin1<br>Quadrant |
|------------|---------|------|------|--------------------------|-----------------------|---------|---------|---------|------------|-----------|------------------|
| LT1013CDR  | D       | 8    | FMX  | 330                      | 12                    | 6.4     | 5.2     | 2.1     | 8          | 12        | Q1               |
| LT1013DDR  | D       | 8    | FMX  | 330                      | 12                    | 6.4     | 5.2     | 2.1     | 8          | 12        | Q1               |
| LT1013DIDR | D       | 8    | FMX  | 330                      | 12                    | 6.4     | 5.2     | 2.1     | 8          | 12        | Q1               |

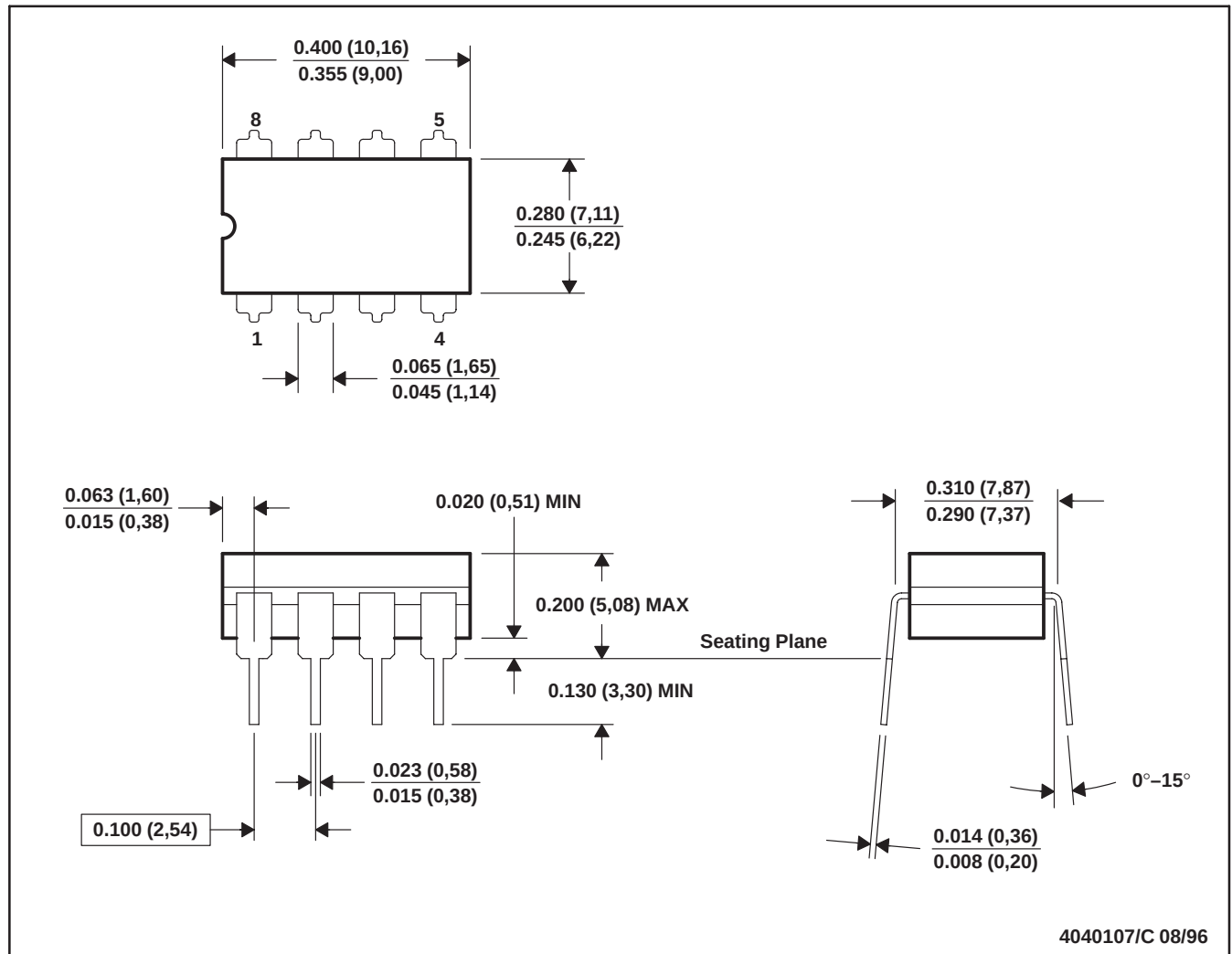

**TAPE AND REEL BOX INFORMATION**

| Device     | Package | Pins | Site | Length (mm) | Width (mm) | Height (mm) |
|------------|---------|------|------|-------------|------------|-------------|
| LT1013CDR  | D       | 8    | FMX  | 342.9       | 336.6      | 20.64       |
| LT1013DDR  | D       | 8    | FMX  | 342.9       | 336.6      | 20.64       |
| LT1013DIDR | D       | 8    | FMX  | 342.9       | 336.6      | 20.64       |



JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE

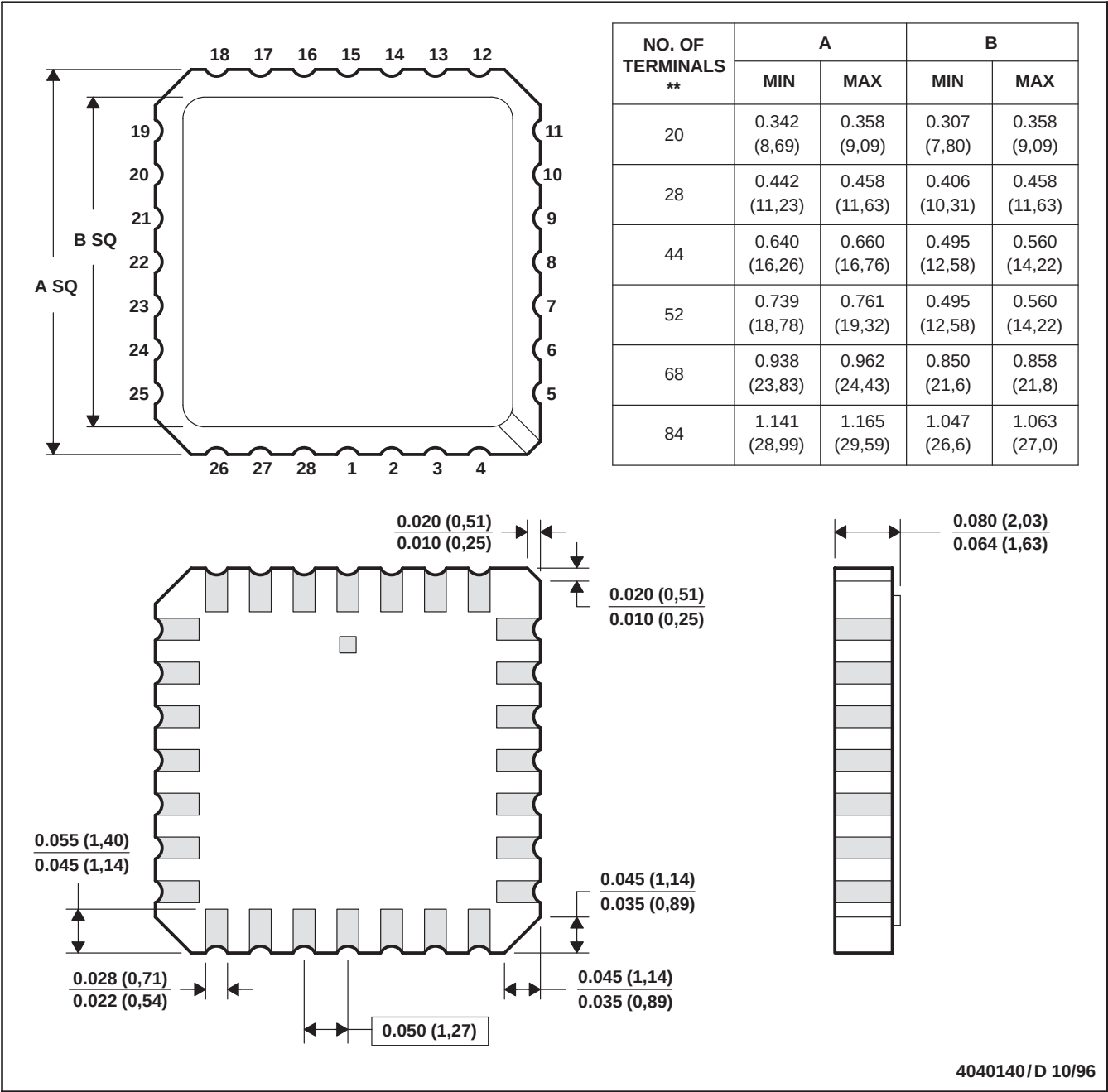


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification.
  - E. Falls within MIL STD 1835 GDIP1-T8

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

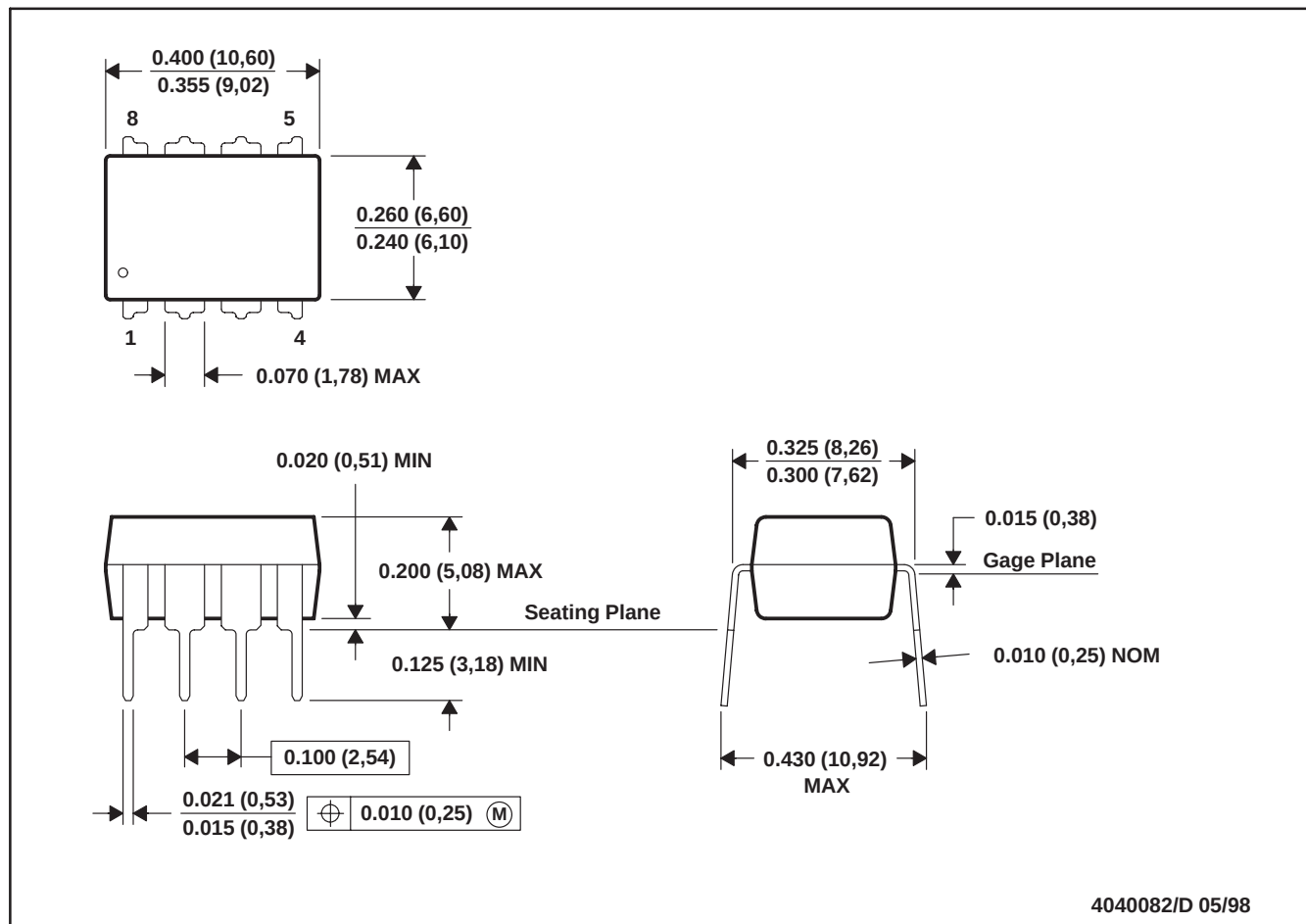
28 TERMINAL SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a metal lid.
  - D. The terminals are gold plated.
  - E. Falls within JEDEC MS-004

## P (R-PDIP-T8)

## PLASTIC DUAL-IN-LINE

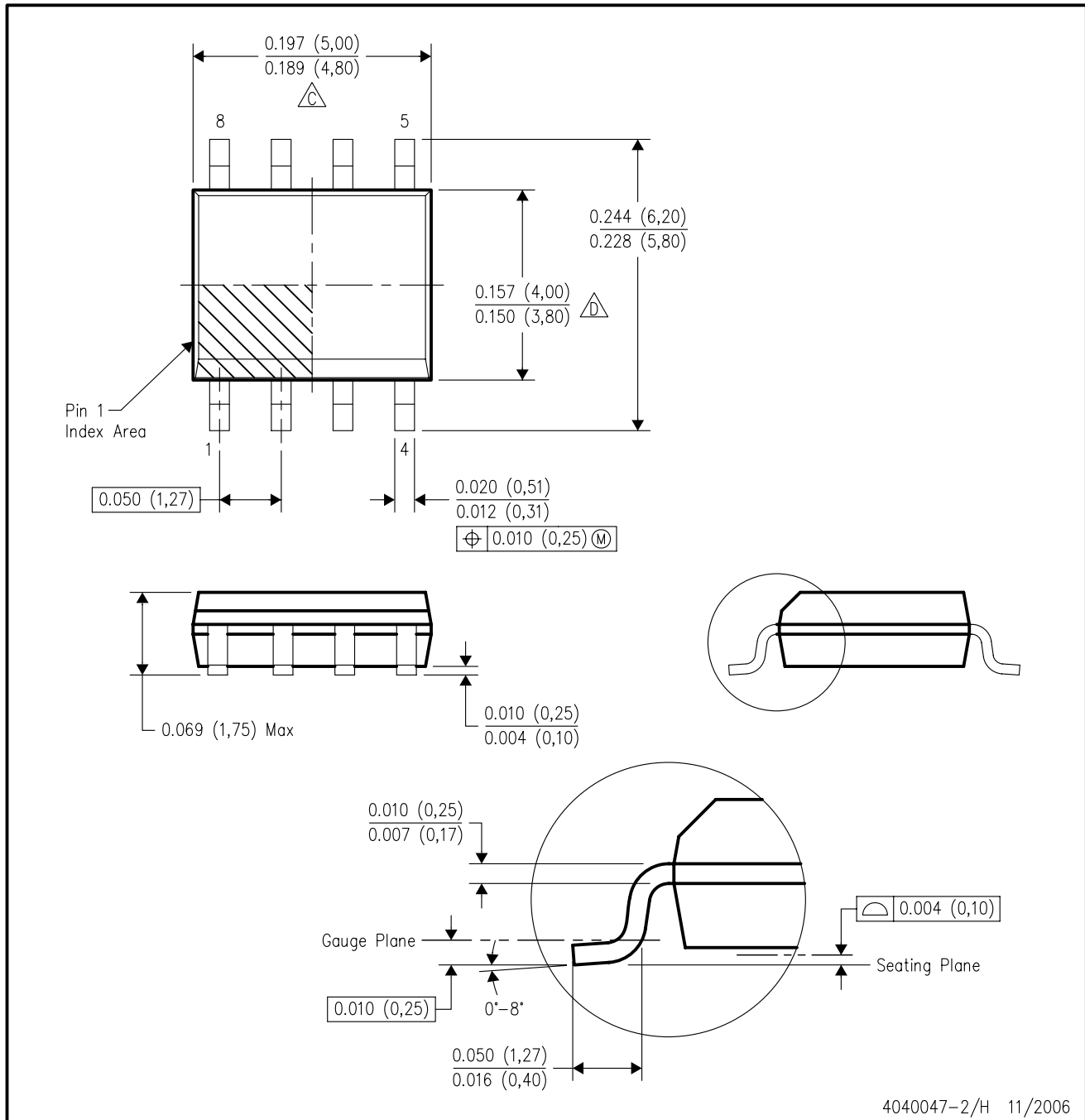


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001

For the latest package information, go to [http://www.ti.com/sc/docs/package/pkg\\_info.htm](http://www.ti.com/sc/docs/package/pkg_info.htm)

## D (R-PDSO-G8)

## PLASTIC SMALL-OUTLINE PACKAGE



4040047-2/H 11/2006

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
  - Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AA.



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| Data Converters       | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     | Automotive         | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
| DSP                   | <a href="http://dsp.ti.com">dsp.ti.com</a>                         | Broadband          | <a href="http://www.ti.com/broadband">www.ti.com/broadband</a>           |
| Interface             | <a href="http://interface.ti.com">interface.ti.com</a>             | Digital Control    | <a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a> |
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| Power Mgmt            | <a href="http://power.ti.com">power.ti.com</a>                     | Optical Networking | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
| Microcontrollers      | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> | Security           | <a href="http://www.ti.com/security">www.ti.com/security</a>             |
| RFID                  | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               | Telephony          | <a href="http://www.ti.com/telephony">www.ti.com/telephony</a>           |
| Low Power<br>Wireless | <a href="http://www.ti.com/lpw">www.ti.com/lpw</a>                 | Video & Imaging    | <a href="http://www.ti.com/video">www.ti.com/video</a>                   |
|                       |                                                                    | Wireless           | <a href="http://www.ti.com/wireless">www.ti.com/wireless</a>             |