

# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

## Operational Amplifier, Rail-to-Rail Output, 3 MHz BW

The NCx2007x series operational amplifiers provide rail-to-rail output operation, 3 MHz bandwidth, and are available in single, dual, and quad configurations. Rail-to-rail operation enables the user to make optimal use of the entire supply voltage range while taking advantage of 3 MHz bandwidth. The NCx2007x can operate on supply voltages as low as 2.7 V over the temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . At a 2.7 V supply, the high bandwidth provides a slew rate of  $2.8\text{ V}/\mu\text{s}$  while only consuming  $405\text{ }\mu\text{A}$  of quiescent current per channel. The wide supply range allows the NCx2007x to run on supply voltages as high as 36 V, making it ideal for a broad range of applications. Since this is a CMOS device, high input impedance and low bias currents make it ideal for interfacing to a wide variety of signal sensors. The NCx2007x devices are available in a variety of compact packages. Automotive qualified options are available under the NCV prefix.

### Features

- Rail-To-Rail Output
- Wide Supply Range: 2.7 V to 36 V
- Wide Bandwidth: 3 MHz typical at  $V_S = 2.7\text{ V}$
- High Slew Rate:  $2.8\text{ V}/\mu\text{s}$  typical at  $V_S = 2.7\text{ V}$
- Low Supply Current:  $405\text{ }\mu\text{A}$  per channel at  $V_S = 2.7\text{ V}$
- Low Input Bias Current:  $5\text{ pA}$  typical
- Wide Temperature Range:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- Available in a variety of packages
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

- Current Sensing
- Signal Conditioning
- Automotive

### End Products

- Notebook Computers
- Portable Instruments
- Power Supplies



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SOT-553  
CASE 463B



TSOP-5  
CASE 483



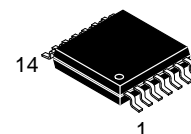
Micro8™  
CASE 846A



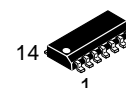
SOIC-8  
CASE 751



TSSOP-8  
CASE 948S



TSSOP-14  
CASE 948G



SOIC-14 NB  
CASE 751A

### DEVICE MARKING INFORMATION

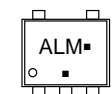
See general marking information in the device marking section on page 2 of this data sheet.

### ORDERING INFORMATION

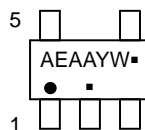
See detailed ordering and shipping information on page 4 of this data sheet.

## MARKING DIAGRAMS

### Single Channel Configuration NCS20071, NCV20071

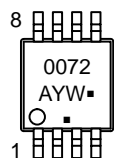


**SOT-553  
CASE 463B**

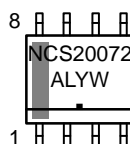


**TSOP-5  
CASE 483**

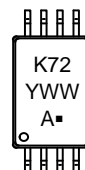
### Dual Channel Configuration NCS20072, NCV20072



**Micro8™  
CASE 846A**

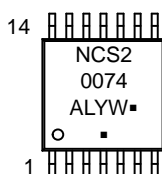


**SOIC-8  
CASE 751**

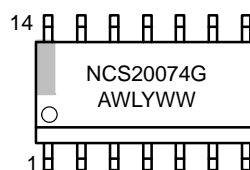


**TSSOP-8  
CASE 948S**

### Quad Channel Configuration NCS20074, NCV20074



**TSSOP-14  
CASE 948G**



**SOIC-14 NB  
CASE 751A**

XXXXX = Specific Device Code

A = Assembly Location

WL, L = Wafer Lot

Y = Year

WW, W = Work Week

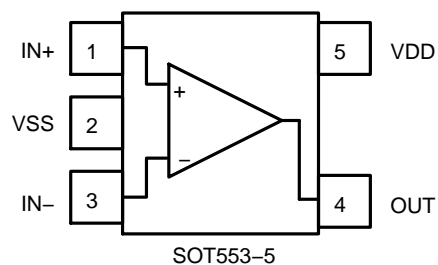
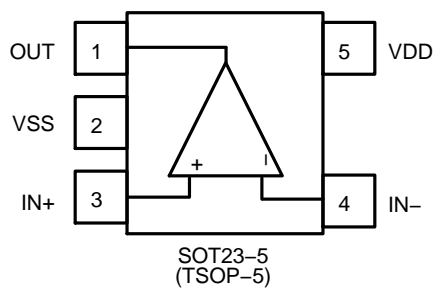
G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

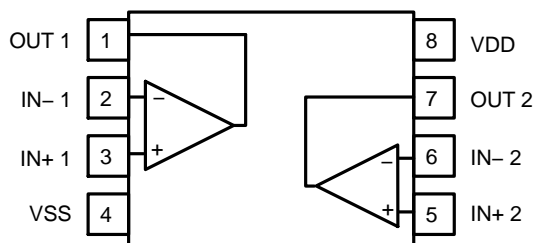
## Single Channel Configuration

NCS20071, NCV20071



## Dual Channel Configuration

NCS20072, NCV20072



## Quadruple Channel Configuration

NCS20074, NCV20074

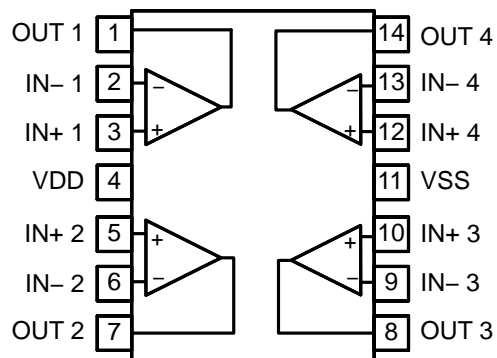


Figure 1. Pin Connections

# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

## ORDERING INFORMATION

| Device           | Configuration | Automotive | Marking  | Package                     | Shipping†            |
|------------------|---------------|------------|----------|-----------------------------|----------------------|
| NCS20071SN2T1G   | Single        | No         | AEA      | TSOP-5<br>(Pb-Free)         | 3000 / Tape and Reel |
| NCS20071XV53T2G  |               |            | AL       | SOT553-5<br>(Pb-Free)       | 4000 / Tape and Reel |
| NCV20071SN2T1G*  |               | Yes        | AEA      | TSOP-5<br>(Pb-Free)         | 3000 / Tape and Reel |
| NCV20071XV53T2G* |               |            | AL       | SOT553-5<br>(Pb-Free)       | 4000 / Tape and Reel |
| NCS20072DMR2G    | Dual          | No         | 0072     | Micro8 (MSOP8)<br>(Pb-Free) | 4000 / Tape and Reel |
| NCS20072DR2G     |               |            | NCS20072 | SOIC-8<br>(Pb-Free)         | 2500 / Tape and Reel |
| NCS20072DTBR2G   |               |            | K72      | TSSOP-8<br>(Pb-Free)        | 2500 / Tape and Reel |
| NCV20072DMR2G*   |               | Yes        | 0072     | Micro8 (MSOP8)<br>(Pb-Free) | 4000 / Tape and Reel |
| NCV20072DR2G*    |               |            | NCS20072 | SOIC-8<br>(Pb-Free)         | 2500 / Tape and Reel |
| NCV20072DTBR2G*  |               |            | K72      | TSSOP-8<br>(Pb-Free)        | 2500 / Tape and Reel |
| NCS20074DR2G     | Quad          | No         | NCS20074 | SOIC-14<br>(Pb-Free)        | 2500 / Tape and Reel |
| NCS20074DTBR2G   |               |            | NCS20074 | TSSOP-14<br>(Pb-Free)       | 2500 / Tape and Reel |
| NCV20074DR2G*    |               | Yes        | NCS20074 | SOIC-14<br>(Pb-Free)        | 2500 / Tape and Reel |
| NCV20074DTBR2G*  |               |            | NCS20074 | TSSOP-14<br>(Pb-Free)       | 2500 / Tape and Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

| Rating   | Symbol   | Limit                            | Unit   |
|--|--|----------------------------------|--|
| Supply Voltage ( $V_{DD} - V_{SS}$ ) (Note 4)          | $V_S$  | 40                               | V  |
| Input Voltage  | $V_{CM}$   | $V_{SS} - 0.2$ to $V_{DD} + 0.2$ | V  |
| Differential Input Voltage (Note 2)                    | $V_{ID}$   | $\pm V_S$                        | V  |
| Maximum Input Current                                  | $I_{IN}$   | $\pm 10$                         | mA   |
| Maximum Output Current (Note 3)                        | $I_O$  | $\pm 100$                        | mA   |
| Continuous Total Power Dissipation (Note 4)            | $P_D$  | 200                              | mW   |
| Maximum Junction Temperature                           | $T_J$  | 150                              | °C   |
| Storage Temperature Range                              | $T_{STG}$  | -65 to 150                       | °C   |
| Mounting Temperature (Infrared or Convection – 20 sec) | $T_{mount}$  | 260                              | °C   |
| ESD Capability (Note 5)                                | Human Body Model<br>Machine Model – NCx20071<br>Machine Model – NCx20072, NCx20074<br>Charged Device Model – NCx20071, NCx20072<br>Charged Device Model – NCx20074 | HBM<br>MM<br>MM<br>CDM<br>CDM    | 2000<br>200<br>150<br>2000 (C6)<br>1000 (C6) |
| Latch-Up Current (Note 6)                              | $I_{LU}$   | 100                              | mA   |
| Moisture Sensitivity Level (Note 7)                    | MSL  | Level 1                          |  |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
2. Maximum input current must be limited to  $\pm 10$  mA. Series connected resistors of at least 500  $\Omega$  on both inputs may be used to limit the maximum input current to  $\pm 10$  mA.
3. Total power dissipation must be limited to prevent the junction temperature from exceeding the 150°C limit.
4. Continuous short circuit operation to ground at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150°C. Output currents in excess of the maximum output current rating over the long term may adversely affect reliability. Shorting output to either VDD or VSS will adversely affect reliability.
5. This device series incorporates ESD protection and is tested by the following methods:  
ESD Human Body Model tested per JEDEC standard JS-001 (AEC-Q100-002)  
ESD Machine Model tested per JEDEC standard JESD22-A115 (AEC-Q100-003)  
ESD Charged Device Model tested per JEDEC standard JESD22-C101 (AEC-Q100-011)
6. Latch-up Current tested per JEDEC standard JESD78 (AEC-Q100-004)
7. Moisture Sensitivity Level tested per IPC/JEDEC standard J-STD-020A

**THERMAL INFORMATION**

| Parameter           | Symbol        | Package         | Single Layer Board (Note 8) | Multi-Layer Board (Note 9) | Unit |
|---------------------|---------------|-----------------|-----------------------------|----------------------------|------|
| Junction-to-Ambient | $\theta_{JA}$ | SOT23-5 / TSOP5 | 265                         | 195                        | °C/W |
|                     |               | SOT553-5        | 325                         | 244                        |      |
|                     |               | Micro8 / MSOP8  | 236                         | 167                        |      |
|                     |               | SOIC-8          | 190                         | 131                        |      |
|                     |               | TSSOP-8         | 253                         | 194                        |      |
|                     |               | SOIC-14         | 142                         | 101                        |      |
|                     |               | TSSOP-14        | 179                         | 128                        |      |

8. Values based on a 1S standard PCB according to JEDEC51-3 with 1.0 oz copper and a 300 mm<sup>2</sup> copper area

9. Values based on a 1S2P standard PCB according to JEDEC51-7 with 1.0 oz copper and a 100 mm<sup>2</sup> copper area

**OPERATING RANGES**

| Parameter                                | Symbol   | Min        | Max             | Unit |
|--|----------|------------|-----------------|------|
| Operating Supply Voltage (Single Supply) | $V_S$    | 2.7        | 36              | V    |
| Operating Supply Voltage (Split Supply)  | $V_S$    | $\pm 1.35$ | $\pm 18$        | V    |
| Differential Input Voltage (Note 10)     | $V_{ID}$ |            | $V_S$           | V    |
| Input Common Mode Voltage Range          | $V_{CM}$ | $V_{SS}$   | $V_{DD} - 1.35$ | V    |
| Ambient Temperature                      | $T_A$    | -40        | 125             | °C   |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

10. Maximum input current must be limited to  $\pm 10$  mA. See Absolute Maximum Ratings for more information.

# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 2.7\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 11, 12)

| Parameter                      | Symbol                   | Conditions   | Min      | Typ       | Max                         | Unit                         |
|--------------------------------|--------------------------|--|----------|-----------|-----------------------------|------------------------------|
| <b>INPUT CHARACTERISTICS</b>   |                          |  |          |           |                             |                              |
| Input Offset Voltage           | $V_{OS}$                 | NCx20071   |          | 1.3       | $\pm 3.5$                   | mV                           |
|                                |                          |  |          |           | <b><math>\pm 4.5</math></b> |                              |
|                                |                          | NCx20072, NCx20074   |          | 1.3       | $\pm 3$                     |                              |
|                                |                          |  |          |           | <b><math>\pm 4</math></b>   |                              |
| Offset Voltage Drift           | $\Delta V_{OS}/\Delta T$ | $T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$              |          | 2         |                             | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current (Note 12)   | $I_{IB}$                 |  |          | 5         | 200                         | pA                           |
|                                |                          |  |          |           | <b>1500</b>                 |                              |
| Input Offset Current (Note 12) | $I_{OS}$                 | NCx20071, NCx20072   |          | 2         | 75                          | pA                           |
|                                |                          |  |          |           | <b>500</b>                  |                              |
|                                |                          | NCx20074   |          | 2         | 75                          |                              |
|                                |                          |  |          |           | <b>200</b>                  |                              |
| Channel Separation             | XTLK                     | DC   | NCx20072 | 100       |                             | dB                           |
|                                |                          |  | NCx20074 | 115       |                             |                              |
| Differential Input Resistance  | $R_{ID}$                 |  |          | 5         |                             | $\text{G}\Omega$             |
| Common Mode Input Resistance   | $R_{IN}$                 |  |          | 5         |                             | $\text{G}\Omega$             |
| Differential Input Capacitance | $C_{ID}$                 |  |          | 1.5       |                             | pF                           |
| Common Mode Input Capacitance  | $C_{CM}$                 |  |          | 3.5       |                             | pF                           |
| Common Mode Rejection Ratio    | CMRR                     | $V_{CM} = V_{SS} + 0.2\text{ V}$ to $V_{DD} - 1.35\text{ V}$ |          | 90        | 110                         | dB                           |
|                                |                          |  |          | <b>69</b> |                             |                              |

## OUTPUT CHARACTERISTICS

|                                     |           |   |  |           |             |    |
|-------------------------------------|-----------|---|--|-----------|-------------|----|
| Open Loop Voltage Gain              | $A_{VOL}$ |   |  | 96        | 118         | dB |
|                                     |           |   |  | <b>86</b> |             |    |
| Output Current Capability (Note 13) | $I_O$     | Op amp sinking current                  |  |           | 70          | mA |
|                                     |           | Op amp sourcing current                 |  |           | 50          |    |
| Output Voltage High                 | $V_{OH}$  | Voltage output swing from positive rail |  |           | 0.006       | V  |
|                                     |           |   |  |           | <b>0.22</b> |    |
| Output Voltage Low                  | $V_{OL}$  | Voltage output swing from negative rail |  |           | 0.005       | V  |
|                                     |           |   |  |           | <b>0.22</b> |    |

## AC CHARACTERISTICS

|                         |             |  |                        |  |     |                        |
|-------------------------|-------------|--|------------------------|--|-----|------------------------|
| Unity Gain Bandwidth    | UGBW        | $C_L = 25\text{ pF}$                                     |                        |  | 3   | MHz                    |
| Slew Rate at Unity Gain | SR          | $C_L = 20\text{ pF}$ , $R_L = 2\text{ k}\Omega$          |                        |  | 2.8 | $\text{V}/\mu\text{s}$ |
| Phase Margin            | $\varphi_m$ | $C_L = 25\text{ pF}$                                     |                        |  | 50  | $^\circ$               |
| Gain Margin             | $A_m$       | $C_L = 25\text{ pF}$                                     |                        |  | 14  | dB                     |
| Settling Time           | $t_s$       | $V_O = 1\text{ Vpp}$ ,<br>Gain = 1, $C_L = 20\text{ pF}$ | Settling time to 0.1%  |  | 0.6 | $\mu\text{s}$          |
|                         |             |  | Settling time to 0.01% |  | 1.2 |                        |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

11. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

12. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

13. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.

# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 2.7\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 11, 12)

| Parameter                            | Symbol | Conditions   | Min | Typ  | Max | Unit                         |
|--------------------------------------|--------|--|-----|------|-----|------------------------------|
| <b>NOISE CHARACTERISTICS</b>         |        |  |     |      |     |                              |
| Total Harmonic Distortion plus Noise | THD+N  | $V_{IN} = 0.5\text{ Vpp}$ , $f = 1\text{ kHz}$ , $A_v = 1$ |     | 0.05 |     | %                            |
| Input Referred Voltage Noise         | $e_n$  | $f = 1\text{ kHz}$   |     | 30   |     | $\text{nV}/\sqrt{\text{Hz}}$ |
|                                      |        | $f = 10\text{ kHz}$  |     | 20   |     |                              |
| Input Referred Current Noise         | $i_n$  | $f = 1\text{ kHz}$   |     | 90   |     | $\text{fA}/\sqrt{\text{Hz}}$ |

## SUPPLY CHARACTERISTICS

|                                |          |                    |                      |            |     |            |               |
|--------------------------------|----------|--------------------|----------------------|------------|-----|------------|---------------|
| Power Supply Rejection Ratio   | PSRR     | No Load            |                      | 114        | 135 |            | dB            |
|                                |          |                    |                      | <b>100</b> |     |            |               |
| Power Supply Quiescent Current | $I_{DD}$ | NCx20071           | No load              |            | 420 | 625        | $\mu\text{A}$ |
|                                |          |                    |                      |            |     | <b>765</b> |               |
|                                |          | NCx20072, NCx20074 | Per channel, no load |            | 405 | 525        |               |
|                                |          |                    |                      |            |     | <b>625</b> |               |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

11. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

12. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

13. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.

## ELECTRICAL CHARACTERISTICS AT $V_S = 5\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 14, 15)

| Parameter                      | Symbol                   | Conditions                                      | Min      | Typ | Max                         | Unit                         |
|--------------------------------|--------------------------|---|----------|-----|-----------------------------|------------------------------|
| <b>INPUT CHARACTERISTICS</b>   |                          |   |          |     |                             |                              |
| Input Offset Voltage           | $V_{OS}$                 | NCx20071  |          | 1.3 | $\pm 3.5$                   | mV                           |
|                                |                          |   |          |     | <b><math>\pm 4.5</math></b> |                              |
|                                |                          | NCx20072, NCx20074                              |          | 1.3 | $\pm 3$                     |                              |
|                                |                          |   |          |     | <b><math>\pm 4</math></b>   |                              |
| Offset Voltage Drift           | $\Delta V_{OS}/\Delta T$ | $T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$ |          | 2   |                             | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current (Note 15)   | $I_{IB}$                 |   |          | 5   | 200                         | $\text{pA}$                  |
|                                |                          |   |          |     | <b>1500</b>                 |                              |
| Input Offset Current (Note 15) | $I_{OS}$                 | NCx20071, NCx20072                              |          | 2   | 75                          | $\text{pA}$                  |
|                                |                          |   |          |     | <b>500</b>                  |                              |
|                                |                          | NCx20074  |          | 2   | 75                          |                              |
|                                |                          |   |          |     | <b>200</b>                  |                              |
| Channel Separation             | XTLK                     | DC  | NCx20072 | 100 |                             | dB                           |
|                                |                          |   | NCx20074 | 115 |                             |                              |
| Differential Input Resistance  | $R_{ID}$                 |   |          | 5   |                             | $\text{G}\Omega$             |
| Common Mode Input Resistance   | $R_{IN}$                 |   |          | 5   |                             | $\text{G}\Omega$             |
| Differential Input Capacitance | $C_{ID}$                 |   |          | 1.5 |                             | pF                           |
| Common Mode Input Capacitance  | $C_{CM}$                 |   |          | 3.5 |                             | pF                           |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

14. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

15. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

16. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.

# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 5\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis.

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 14, 15)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|-----------|--------|------------|-----|-----|-----|------|
|-----------|--------|------------|-----|-----|-----|------|

### INPUT CHARACTERISTICS

|                             |      |  |           |     |  |    |
|-----------------------------|------|--|-----------|-----|--|----|
| Common Mode Rejection Ratio | CMRR | $V_{CM} = V_{SS} + 0.2\text{ V}$ to $V_{DD} - 1.35\text{ V}$ | 102       | 125 |  | dB |
|                             |      |  | <b>80</b> |     |  |    |

### OUTPUT CHARACTERISTICS

|                                     |           |   |           |       |             |    |
|-------------------------------------|-----------|---|-----------|-------|-------------|----|
| Open Loop Voltage Gain              | $A_{VOL}$ |   | 96        | 120   |             | dB |
|                                     |           |   | <b>86</b> |       |             |    |
| Output Current Capability (Note 16) | $I_O$     | Op amp sinking current                  |           | 50    |             | mA |
|                                     |           | Op amp sourcing current                 |           | 60    |             |    |
| Output Voltage High                 | $V_{OH}$  | Voltage output swing from positive rail |           | 0.013 | 0.20        | V  |
|                                     |           |   |           |       | <b>0.25</b> |    |
| Output Voltage Low                  | $V_{OL}$  | Voltage output swing from negative rail |           | 0.01  | 0.10        | V  |
|                                     |           |   |           |       | <b>0.15</b> |    |

### AC CHARACTERISTICS

|                         |             |  |                        |     |  |                  |
|-------------------------|-------------|--|------------------------|-----|--|------------------|
| Unity Gain Bandwidth    | UGBW        | $C_L = 25\text{ pF}$                                     |                        | 3   |  | MHz              |
| Slew Rate at Unity Gain | SR          | $C_L = 20\text{ pF}$ , $R_L = 2\text{ k}\Omega$          |                        | 2.7 |  | V/ $\mu\text{s}$ |
| Phase Margin            | $\varphi_m$ | $C_L = 25\text{ pF}$                                     |                        | 50  |  | °                |
| Gain Margin             | $A_m$       | $C_L = 25\text{ pF}$                                     |                        | 14  |  | dB               |
| Settling Time           | $t_s$       | $V_O = 3\text{ Vpp}$ ,<br>Gain = 1, $C_L = 20\text{ pF}$ | Settling time to 0.1%  | 1.2 |  | $\mu\text{s}$    |
|                         |             |  | Settling time to 0.01% | 5.6 |  |                  |

### NOISE CHARACTERISTICS

|                                      |       |  |  |       |  |                        |
|--------------------------------------|-------|--|--|-------|--|------------------------|
| Total Harmonic Distortion plus Noise | THD+N | $V_{IN} = 2.5\text{ Vpp}$ , $f = 1\text{ kHz}$ , $A_v = 1$ |  | 0.009 |  | %                      |
| Input Referred Voltage Noise         | $e_n$ | $f = 1\text{ kHz}$   |  | 30    |  | nV/ $\sqrt{\text{Hz}}$ |
|                                      |       | $f = 10\text{ kHz}$  |  | 20    |  |                        |
| Input Referred Current Noise         | $i_n$ | $f = 1\text{ kHz}$   |  | 90    |  | fA/ $\sqrt{\text{Hz}}$ |

### SUPPLY CHARACTERISTICS

|                                |          |                    |                      |            |     |            |               |
|--------------------------------|----------|--------------------|----------------------|------------|-----|------------|---------------|
| Power Supply Rejection Ratio   | PSRR     | No Load            |                      | 114        | 135 |            | dB            |
|                                |          |                    |                      | <b>100</b> |     |            |               |
| Power Supply Quiescent Current | $I_{DD}$ | NCx20071           | No load              |            | 430 | 635        | $\mu\text{A}$ |
|                                |          |                    |                      |            |     | <b>775</b> |               |
|                                |          | NCx20072, NCx20074 | Per channel, no load |            | 410 | 530        |               |
|                                |          |                    |                      |            |     | <b>630</b> |               |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

14. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

15. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

16. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.



# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 10\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 17, 18)

| Parameter                      | Symbol                   | Conditions   | Min       | Typ | Max                         | Unit                         |
|--------------------------------|--------------------------|--|-----------|-----|-----------------------------|------------------------------|
| <b>INPUT CHARACTERISTICS</b>   |                          |  |           |     |                             |                              |
| Input Offset Voltage           | $V_{OS}$                 | NCx20071   |           | 1.3 | $\pm 3.5$                   | mV                           |
|                                |                          |  |           |     | <b><math>\pm 4.5</math></b> | mV                           |
| Input Offset Voltage           | $V_{OS}$                 | NCx20072, NCx20074   |           | 1.3 | $\pm 3$                     | mV                           |
|                                |                          |  |           |     | <b><math>\pm 4</math></b>   | mV                           |
| Offset Voltage Drift           | $\Delta V_{OS}/\Delta T$ | $T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$              |           | 2   |                             | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current (Note 18)   | $I_{IB}$                 |  |           | 5   | 200                         | pA                           |
|                                |                          |  |           |     | <b>1500</b>                 |                              |
| Input Offset Current (Note 18) | $I_{OS}$                 | NCx20071, NCx20072   |           | 2   | 75                          | pA                           |
|                                |                          |  |           |     | <b>500</b>                  |                              |
|                                |                          | NCx20074   |           | 2   | 75                          |                              |
|                                |                          |  |           |     | <b>200</b>                  |                              |
| Channel Separation             | XTLK                     | DC   |           | 100 |                             | dB                           |
|                                |                          |  |           | 115 |                             |                              |
| Differential Input Resistance  | $R_{ID}$                 |  |           | 5   |                             | $\text{G}\Omega$             |
| Common Mode Input Resistance   | $R_{IN}$                 |  |           | 5   |                             | $\text{G}\Omega$             |
| Differential Input Capacitance | $C_{ID}$                 |  |           | 1.5 |                             | pF                           |
| Common Mode Input Capacitance  | $C_{CM}$                 |  |           | 3.5 |                             | pF                           |
| Common Mode Rejection Ratio    | CMRR                     | $V_{CM} = V_{SS} + 0.2\text{ V}$ to $V_{DD} - 1.35\text{ V}$ | 110       | 130 |                             | dB                           |
|                                |                          |  | <b>87</b> |     |                             |                              |

## OUTPUT CHARACTERISTICS

|                                     |           |   |           |       |             |    |
|-------------------------------------|-----------|---|-----------|-------|-------------|----|
| Open Loop Voltage Gain              | $A_{VOL}$ |   | 98        | 120   |             | dB |
|                                     |           |   | <b>88</b> |       |             |    |
| Output Current Capability (Note 19) | $I_O$     | Op amp sinking current                  |           | 50    |             | mA |
|                                     |           | Op amp sourcing current                 |           | 65    |             |    |
| Output Voltage High                 | $V_{OH}$  | Voltage output swing from positive rail |           | 0.023 | 0.08        | V  |
|                                     |           |   |           |       | <b>0.10</b> |    |
| Output Voltage Low                  | $V_{OL}$  | Voltage output swing from negative rail |           | 0.022 | 0.3         | V  |
|                                     |           |   |           |       | <b>0.35</b> |    |

## AC CHARACTERISTICS

|                         |             |  |                        |     |  |                        |
|-------------------------|-------------|--|------------------------|-----|--|------------------------|
| Unity Gain Bandwidth    | UGBW        | $C_L = 25\text{ pF}$                                       |                        | 3   |  | MHz                    |
| Slew Rate at Unity Gain | SR          | $C_L = 20\text{ pF}$ , $R_L = 2\text{ k}\Omega$            |                        | 2.6 |  | $\text{V}/\mu\text{s}$ |
| Phase Margin            | $\varphi_m$ | $C_L = 25\text{ pF}$                                       |                        | 50  |  | $^\circ$               |
| Gain Margin             | $A_m$       | $C_L = 25\text{ pF}$                                       |                        | 14  |  | dB                     |
| Settling Time           | $t_s$       | $V_O = 8.5\text{ Vpp}$ ,<br>Gain = 1, $C_L = 20\text{ pF}$ | Settling time to 0.1%  | 3.4 |  | $\mu\text{s}$          |
|                         |             |  | Settling time to 0.01% | 6.8 |  |                        |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

17. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

18. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

19. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.

# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 10\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 17, 18)

| Parameter                            | Symbol | Conditions   | Min | Typ   | Max | Unit                         |
|--------------------------------------|--------|--|-----|-------|-----|------------------------------|
| <b>NOISE CHARACTERISTICS</b>         |        |  |     |       |     |                              |
| Total Harmonic Distortion plus Noise | THD+N  | $V_{IN} = 7.5\text{ Vpp}$ , $f = 1\text{ kHz}$ , $A_v = 1$ |     | 0.004 |     | %                            |
| Input Referred Voltage Noise         | $e_n$  | $f = 1\text{ kHz}$   |     | 30    |     | $\text{nV}/\sqrt{\text{Hz}}$ |
|                                      |        | $f = 10\text{ kHz}$  |     | 20    |     |                              |
| Input Referred Current Noise         | $i_n$  | $f = 1\text{ kHz}$   |     | 90    |     | $\text{fA}/\sqrt{\text{Hz}}$ |

## SUPPLY CHARACTERISTICS

|                                |          |                    |                      |            |     |            |               |
|--------------------------------|----------|--------------------|----------------------|------------|-----|------------|---------------|
| Power Supply Rejection Ratio   | PSRR     | No Load            |                      | 114        | 135 |            | dB            |
|                                |          |                    |                      | <b>100</b> |     |            |               |
| Power Supply Quiescent Current | $I_{DD}$ | NCx20071           | No load              |            | 430 | 645        | $\mu\text{A}$ |
|                                |          |                    |                      |            |     | <b>785</b> |               |
|                                |          | NCx20072, NCx20074 | Per channel, no load |            | 416 | 540        |               |
|                                |          |                    |                      |            |     | <b>640</b> |               |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

17. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

18. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

19. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.

## ELECTRICAL CHARACTERISTICS AT $V_S = 36\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 20, 21)

| Parameter                      | Symbol                   | Conditions                                      | Min      | Typ | Max                         | Unit                         |
|--------------------------------|--------------------------|---|----------|-----|-----------------------------|------------------------------|
| <b>INPUT CHARACTERISTICS</b>   |                          |   |          |     |                             |                              |
| Input Offset Voltage           | $V_{OS}$                 | NCx20071  |          | 1.3 | $\pm 3.5$                   | mV                           |
|                                |                          |   |          |     | <b><math>\pm 4.5</math></b> | <b>mV</b>                    |
|                                |                          | NCx20072, NCx20074                              |          | 1.3 | $\pm 3$                     | mV                           |
|                                |                          |   |          |     | <b><math>\pm 4</math></b>   | <b>mV</b>                    |
| Offset Voltage Drift           | $\Delta V_{OS}/\Delta T$ | $T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$ |          | 2   |                             | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current (Note 21)   | $I_{IB}$                 |   |          | 5   | 200                         | pA                           |
|                                |                          | NCx20071, NCx20072                              |          |     | <b>2000</b>                 |                              |
|                                |                          | NCx20074  |          |     | <b>1500</b>                 |                              |
| Input Offset Current (Note 21) | $I_{OS}$                 | NCx20071, NCx20072                              |          | 2   | 75                          | pA                           |
|                                |                          |   |          |     | <b>1000</b>                 |                              |
|                                |                          | NCx20074  |          | 2   | 75                          |                              |
|                                |                          |   |          |     | <b>200</b>                  |                              |
| Channel Separation             | XTLK                     | DC  | NCx20072 | 100 |                             | dB                           |
|                                |                          |   | NCx20074 | 115 |                             |                              |
| Differential Input Resistance  | $R_{ID}$                 |   |          | 5   |                             | $\text{G}\Omega$             |
| Common Mode Input Resistance   | $R_{IN}$                 |   |          | 5   |                             | $\text{G}\Omega$             |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

20. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

21. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

22. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.

# NCS20071, NCV20071, NCS20072, NCV20072, NCS20074, NCV20074

## ELECTRICAL CHARACTERISTICS AT $V_S = 36\text{ V}$

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 20, 21)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|-----------|--------|------------|-----|-----|-----|------|
|-----------|--------|------------|-----|-----|-----|------|

### INPUT CHARACTERISTICS

|                                |          |          |   |           |     |    |
|--------------------------------|----------|----------|---|-----------|-----|----|
| Differential Input Capacitance | $C_{ID}$ |          |   | 1.5       |     | pF |
| Common Mode Input Capacitance  | $C_{CM}$ |          |   | 3.5       |     | pF |
| Common Mode Rejection Ratio    | CMRR     | NCx20071 | $V_{CM} = V_{SS} + 0.2\text{ V to } V_{DD} - 1.35\text{ V}$ | 118       | 135 | dB |
|                                |          |          |   | <b>95</b> |     |    |
|                                |          | NCx20072 | $V_{CM} = V_{SS} + 0.2\text{ V to } V_{DD} - 1.35\text{ V}$ | 120       | 145 |    |
|                                |          |          |   | <b>95</b> |     |    |
|                                |          | NCx20074 | $V_{CM} = V_{SS} + 0.2\text{ V to } V_{DD} - 1.35\text{ V}$ | 120       | 145 |    |
|                                |          |          |   | <b>85</b> |     |    |

### OUTPUT CHARACTERISTICS

|                                     |           |   |           |       |             |    |
|-------------------------------------|-----------|---|-----------|-------|-------------|----|
| Open Loop Voltage Gain              | $A_{VOL}$ |   | 98        | 120   |             | dB |
|                                     |           |   | <b>88</b> |       |             |    |
| Output Current Capability (Note 22) | $I_O$     | Op amp sinking current                  |           | 50    |             | mA |
|                                     |           | Op amp sourcing current                 |           | 65    |             |    |
| Output Voltage High                 | $V_{OH}$  | Voltage output swing from positive rail | NCx20071  | 0.074 | 0.15        | V  |
|                                     |           |   |           |       | <b>0.22</b> |    |
|                                     |           |   | NCx20072  | 0.074 | 0.10        |    |
|                                     |           |   |           |       | <b>0.15</b> |    |
|                                     |           |   | NCx20074  | 0.074 | 0.10        |    |
|                                     |           |   |           |       | <b>0.12</b> |    |
| Output Voltage Low                  | $V_{OL}$  | Voltage output swing from negative rail |           | 0.065 | 0.3         | V  |
|                                     |           |   |           |       | <b>0.35</b> |    |

### AC CHARACTERISTICS

|                         |             |   |                        |     |  |                  |
|-------------------------|-------------|---|------------------------|-----|--|------------------|
| Unity Gain Bandwidth    | UGBW        | $C_L = 25\text{ pF}$                                      |                        | 3   |  | MHz              |
| Slew Rate at Unity Gain | SR          | $C_L = 20\text{ pF}$ , $R_L = 2\text{ k}\Omega$           |                        | 2.4 |  | V/ $\mu\text{s}$ |
| Phase Margin            | $\varphi_m$ | $C_L = 25\text{ pF}$                                      |                        | 50  |  | °                |
| Gain Margin             | $A_m$       | $C_L = 25\text{ pF}$                                      |                        | 14  |  | dB               |
| Settling Time           | $t_s$       | $V_O = 10\text{ Vpp}$ ,<br>Gain = 1, $C_L = 20\text{ pF}$ | Settling time to 0.1%  | 3.2 |  | $\mu\text{s}$    |
|                         |             |   | Settling time to 0.01% | 7   |  |                  |

### NOISE CHARACTERISTICS

|                                      |       |   |  |       |  |                              |
|--------------------------------------|-------|---|--|-------|--|------------------------------|
| Total Harmonic Distortion plus Noise | THD+N | $V_{IN} = 28.5\text{ Vpp}$ , $f = 1\text{ kHz}$ , $A_v = 1$ |  | 0.001 |  | %                            |
| Input Referred Voltage Noise         | $e_n$ | $f = 1\text{ kHz}$  |  | 30    |  | $\text{nV}/\sqrt{\text{Hz}}$ |
|                                      |       | $f = 10\text{ kHz}$   |  | 20    |  |                              |
| Input Referred Current Noise         | $i_n$ | $f = 1\text{ kHz}$  |  | 90    |  | $\text{fA}/\sqrt{\text{Hz}}$ |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

20. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

21. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

22. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.

**ELECTRICAL CHARACTERISTICS AT  $V_S = 36\text{ V}$**

$T_A = 25^\circ\text{C}$ ;  $R_L \geq 10\text{ k}\Omega$ ;  $V_{CM} = V_{OUT} = \text{mid-supply}$  unless otherwise noted. All limits are guaranteed by testing or statistical analysis. Boldface limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ . (Notes 20, 21)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|-----------|--------|------------|-----|-----|-----|------|
|-----------|--------|------------|-----|-----|-----|------|

**SUPPLY CHARACTERISTICS**

|                                |          |          |                      |            |     |            |               |
|--------------------------------|----------|----------|----------------------|------------|-----|------------|---------------|
| Power Supply Rejection Ratio   | PSRR     | No Load  |                      | 114        | 135 |            | dB            |
|                                |          |          |                      | <b>100</b> |     |            |               |
| Power Supply Quiescent Current | $I_{DD}$ | NCx20071 | No load              |            | 480 | 700        | $\mu\text{A}$ |
|                                |          |          |                      |            |     | <b>840</b> |               |
|                                |          | NCx20072 | Per channel, no load |            | 465 | 570        |               |
|                                |          |          |                      |            |     | <b>700</b> |               |
|                                |          | NCx20074 | Per channel, no load |            | 465 | 600        |               |
|                                |          |          |                      |            |     | <b>700</b> |               |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

20. Refer to ABSOLUTE MAXIMUM RATINGS and APPLICATION INFORMATION for Safe Operating Area.

21. Performance guaranteed over the indicated operating temperature range by design and/or characterization.

22. Power dissipation must be limited to prevent junction temperature from exceeding  $150^\circ\text{C}$ . See Absolute Maximum Ratings for more information.

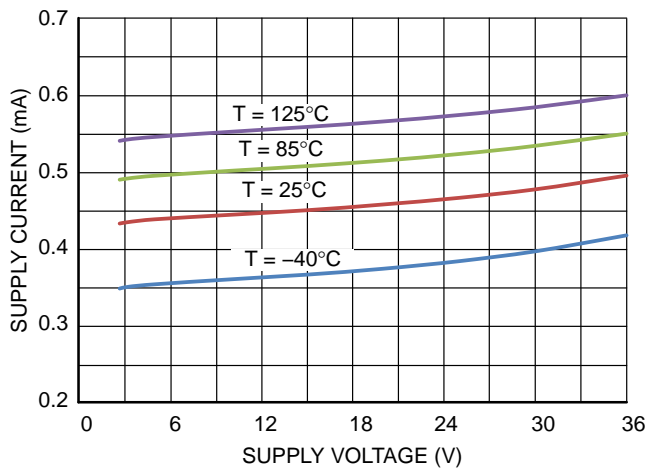


Figure 2. Quiescent Current Per Channel vs. Supply Voltage

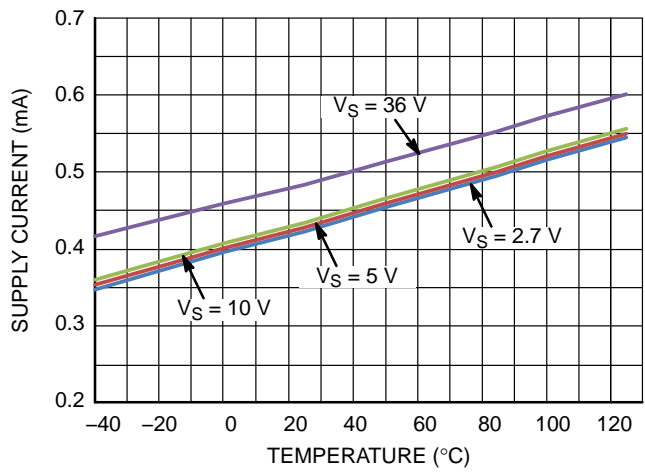


Figure 3. Quiescent Current vs. Temperature

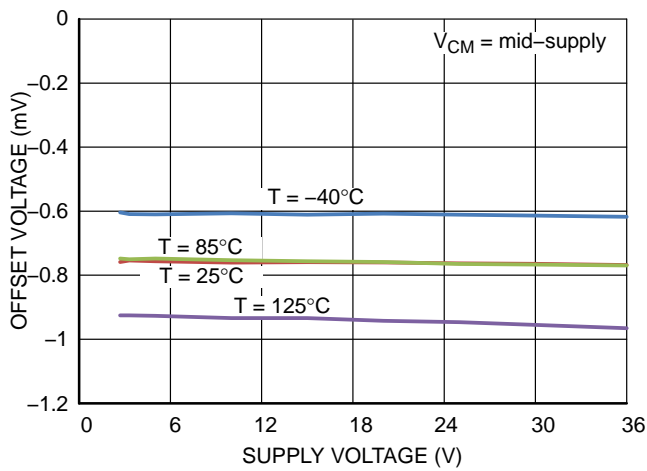


Figure 4. Offset Voltage vs. Supply Voltage

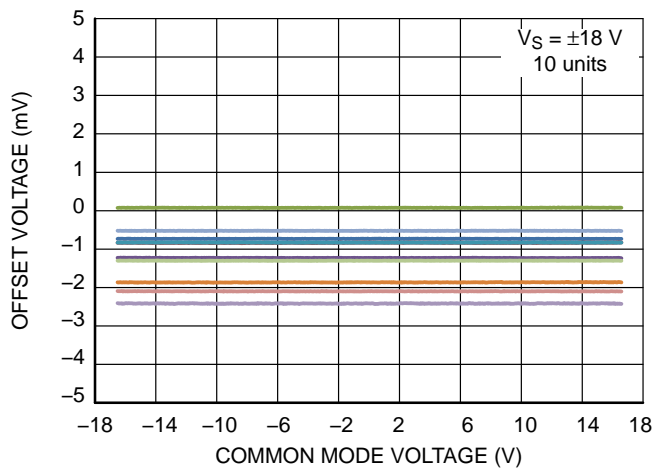


Figure 5. Input Offset Voltage vs. Common Mode Voltage

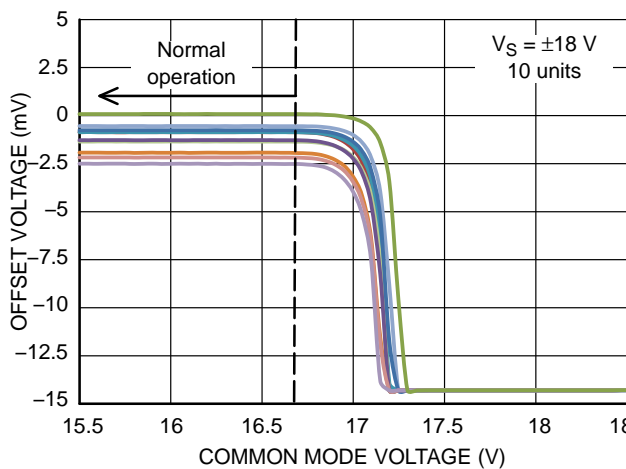


Figure 6. Input Offset Voltage vs. Common Mode Voltage

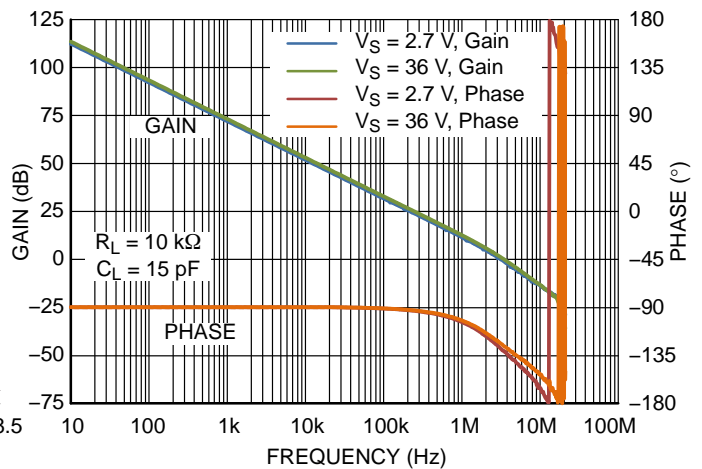


Figure 7. Gain and Phase vs. Frequency

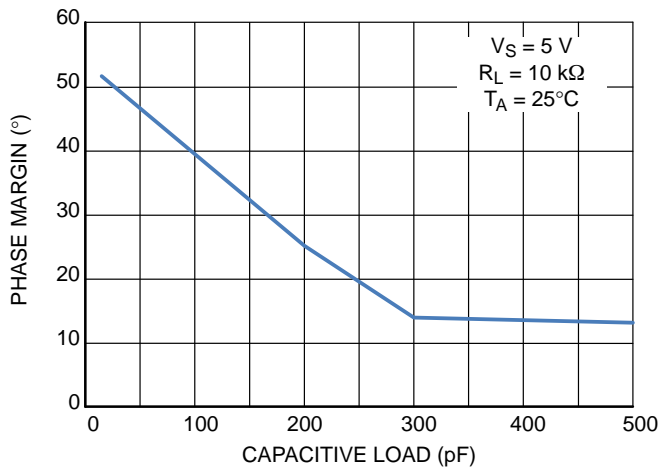


Figure 8. Phase Margin vs. Capacitive Load

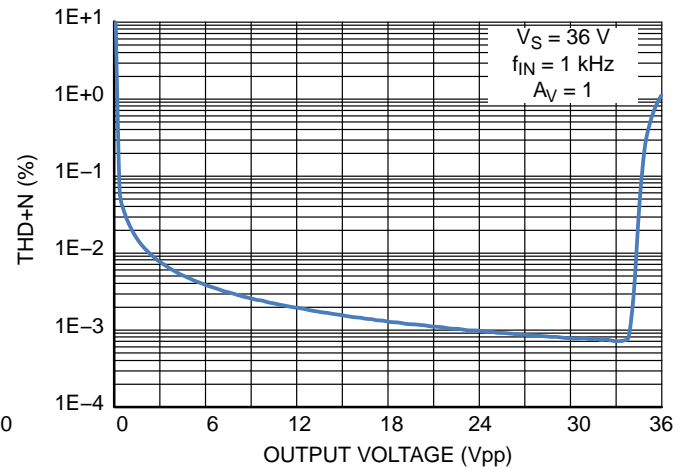


Figure 9. THD+N vs. Output Voltage

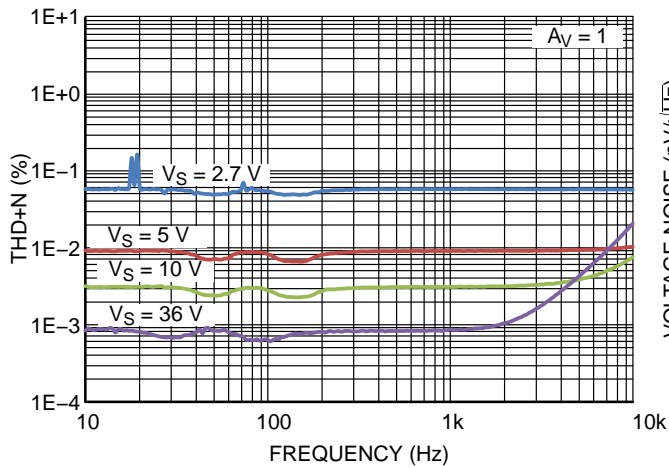


Figure 10. THD+N vs. Frequency

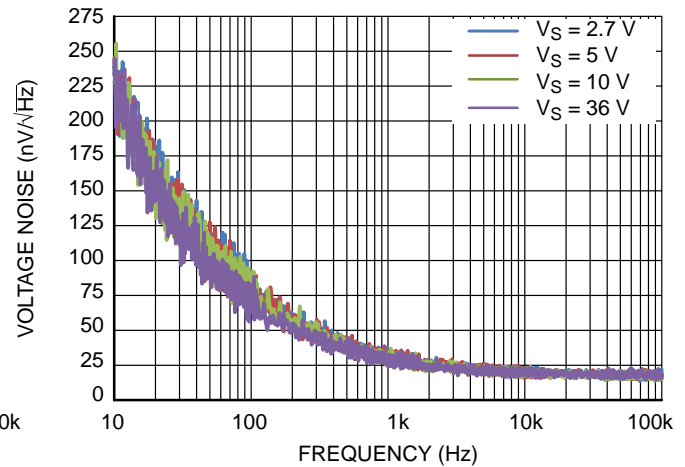


Figure 11. Input Voltage Noise vs. Frequency

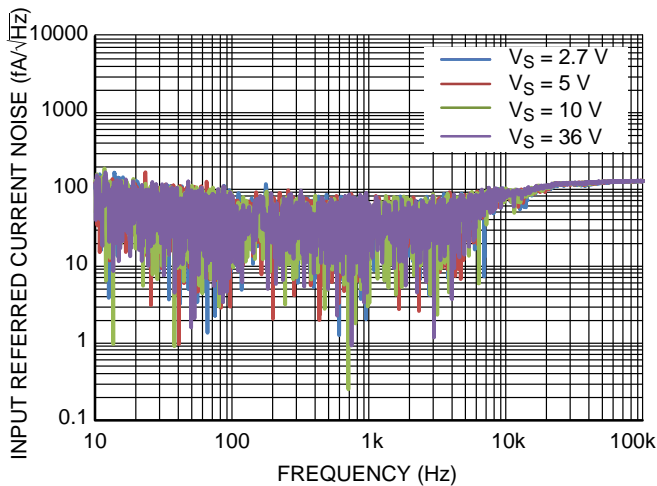


Figure 12. Input Current Noise vs. Frequency

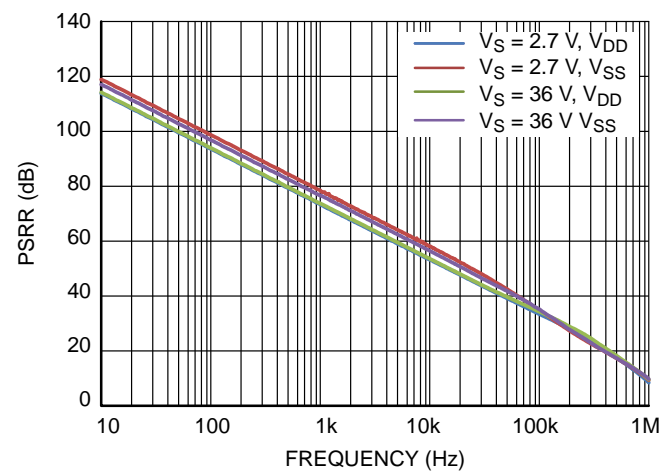


Figure 13. PSRR vs. Frequency

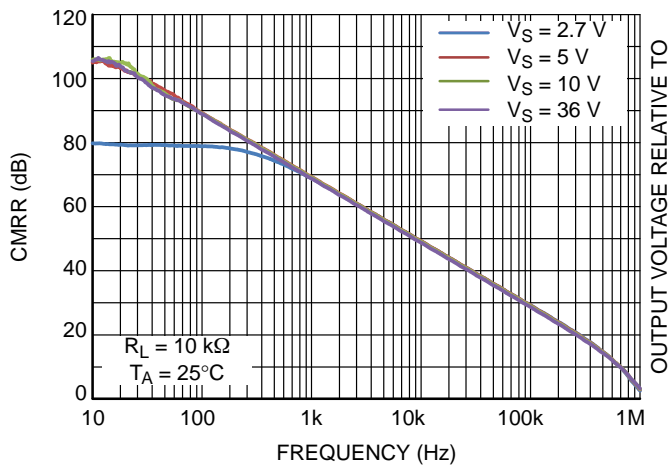


Figure 14. CMRR vs. Frequency

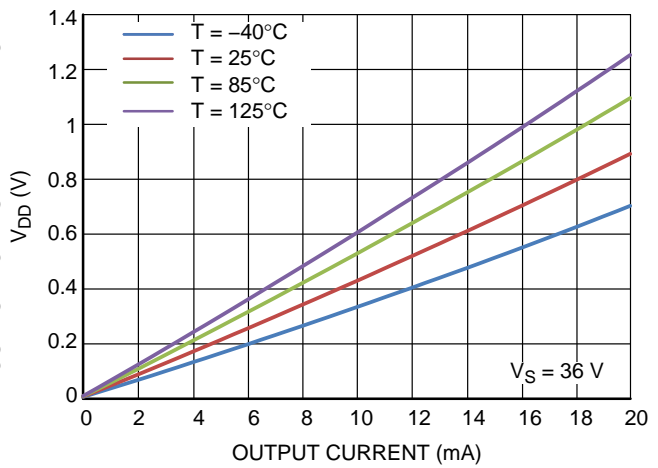


Figure 15. High Level Output vs. Output Current

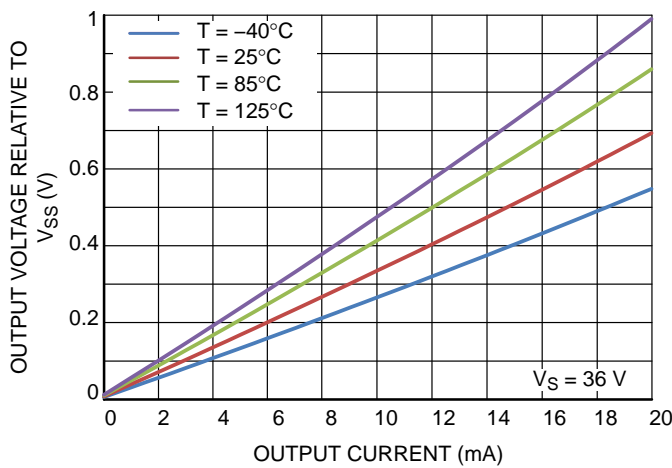


Figure 16. Low Level Output vs. Output Current

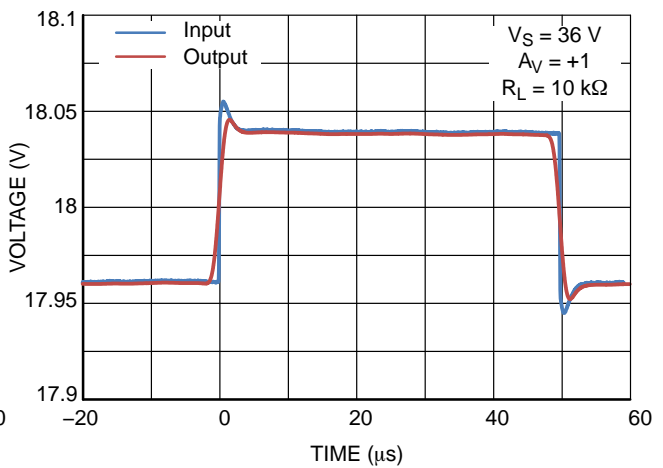


Figure 17. Non-inverting Small Signal Transient Response

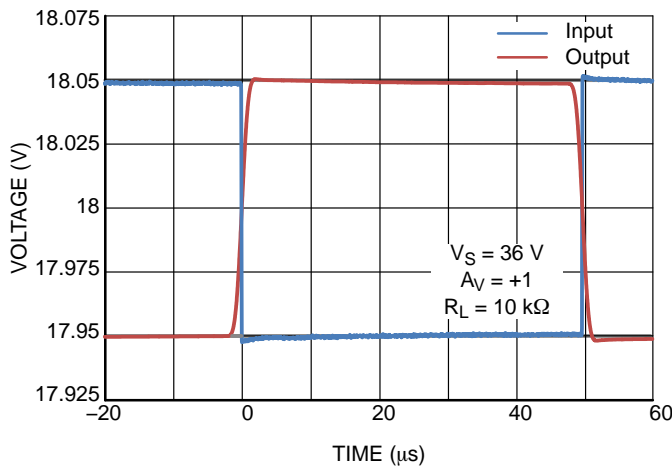


Figure 18. Inverting Small Signal Transient Response

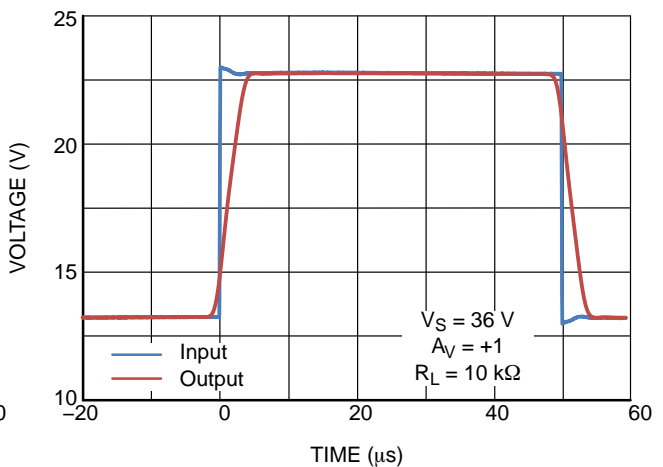


Figure 19. Non-inverting Large Signal Transient Response

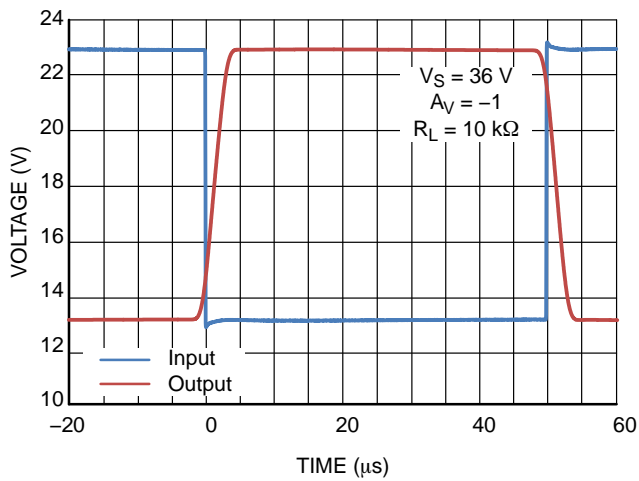


Figure 20. Inverting Large Signal Transient Response

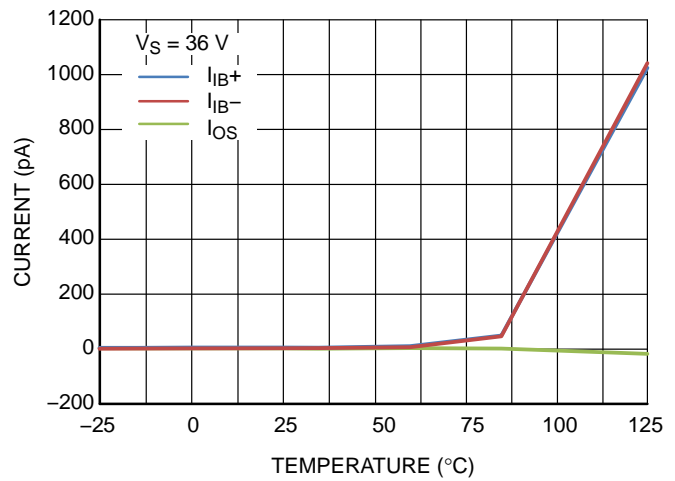


Figure 21. Input Bias and Offset Current vs. Temperature

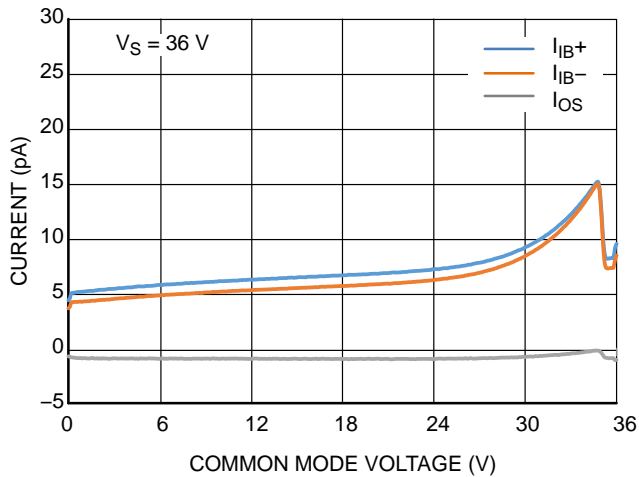


Figure 22. Input Bias Current vs. Common Mode Voltage

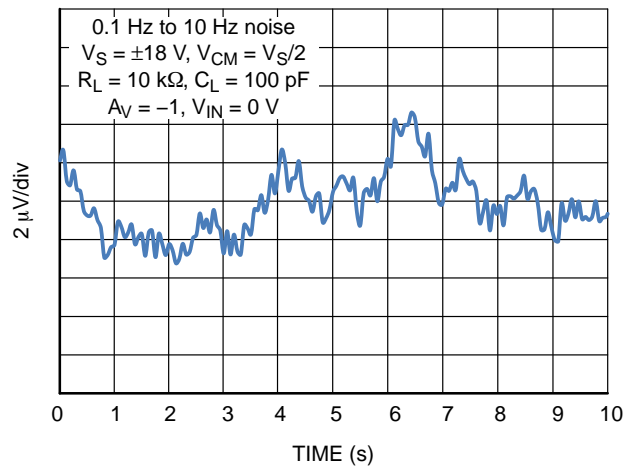


Figure 23. 0.1 Hz to 10 Hz Noise

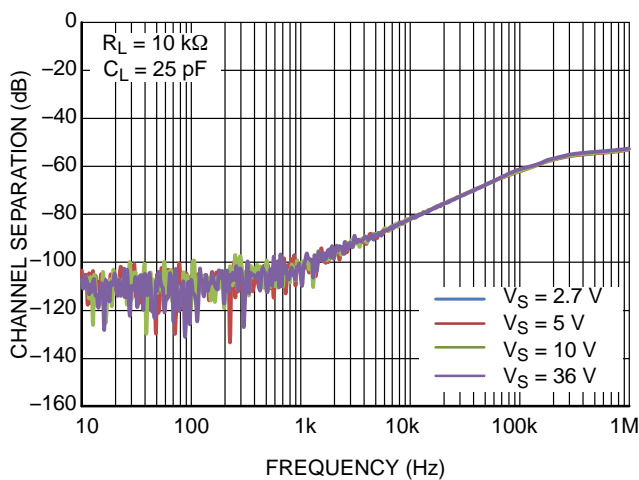


Figure 24. Channel Separation vs. Frequency

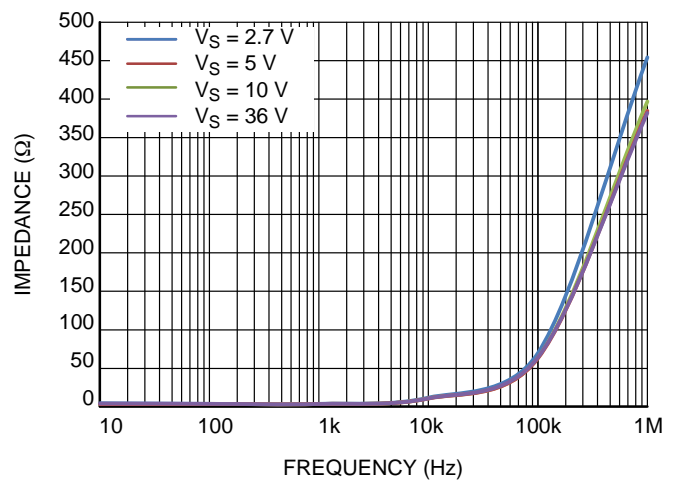


Figure 25. Open Loop Output Impedance



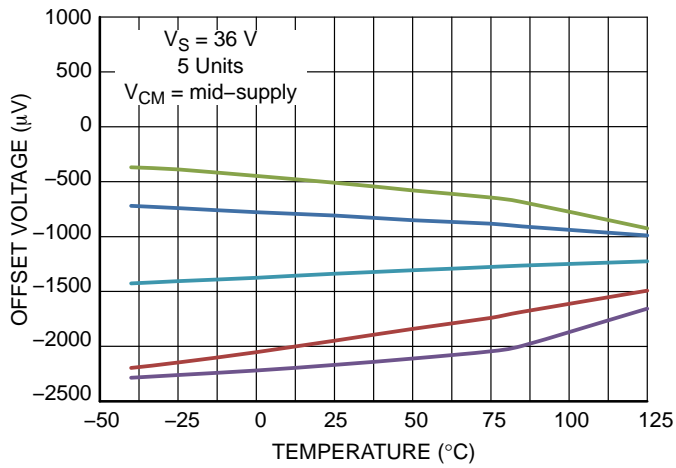


Figure 26. Offset Voltage vs. Temperature

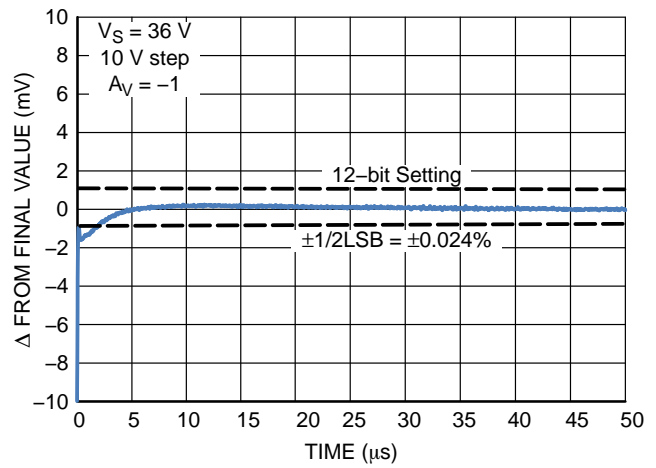


Figure 27. Large Signal Settling Time

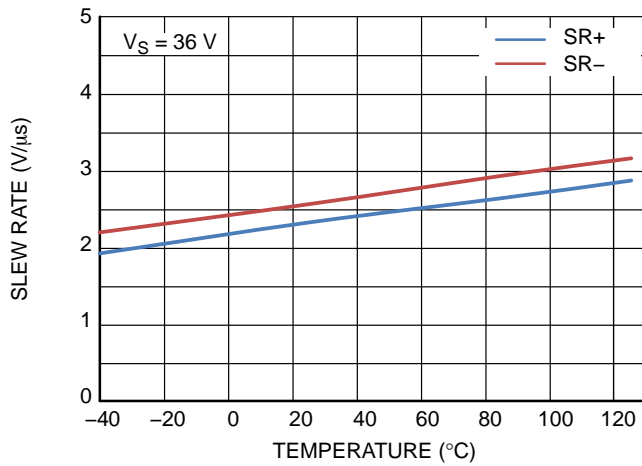


Figure 28. Slew Rate vs. Temperature

## APPLICATIONS INFORMATION

**Input Circuit**

The NCS2007x input stage has a PMOS input pair and ESD protection diodes. The input pair is internally connected by back-to-back Zener diodes with a reverse voltage of 5.5 V. To protect the internal circuitry, the input current must be limited to 10 mA. When operating the

NCS2007x at differential voltages greater than  $V_{ID} = 26$  V, series resistors can be added externally to limit the input current flowing between the input pins. Adding 500  $\Omega$  resistors in series with the input prevents the current from exceeding 10 mA over the entire operating range up to 36 V.

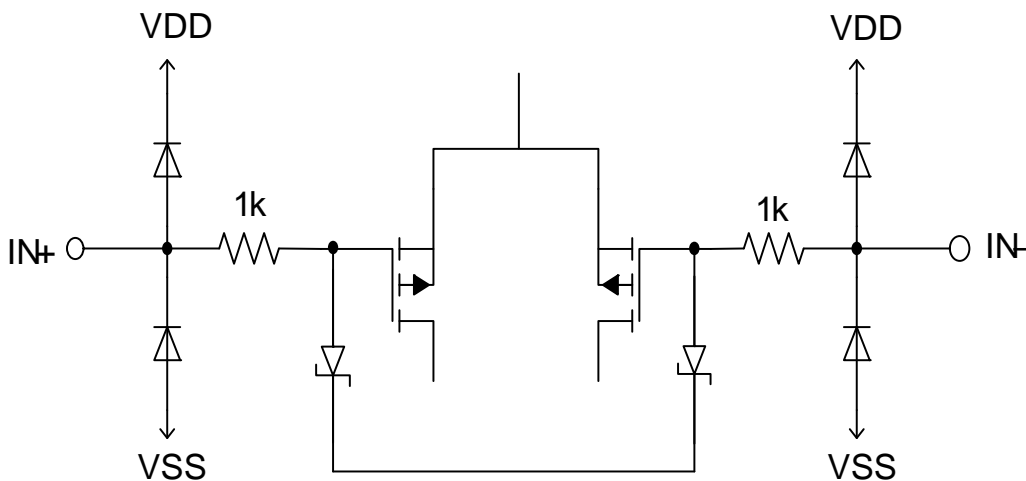


Figure 29. Differential Input Pair

**Output**

The NCS2007x has a class AB output stage with rail-to-rail output swing.

High output currents can cause the junction temperature to exceed the 150°C absolute maximum rating. In the case of a short circuit where the output is connected to either supply rail, the amount of current the op amp can source and sink is described by the output current capability parameter

listed in the Electrical Characteristics. The junction temperature at a given power dissipation,  $P$ , can be calculated using the following formula:

$$T_J = T_A + P \times \theta_{JA}$$

The thermal resistance between junction and ambient,  $\theta_{JA}$ , is provided in the Thermal Information section of this datasheet.

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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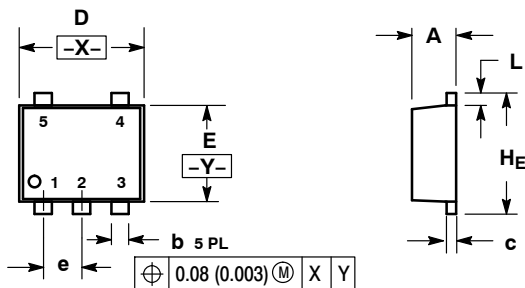
SCALE 4:1

### SOT-553, 5 LEAD

#### CASE 463B

#### ISSUE C

DATE 20 MAR 2013

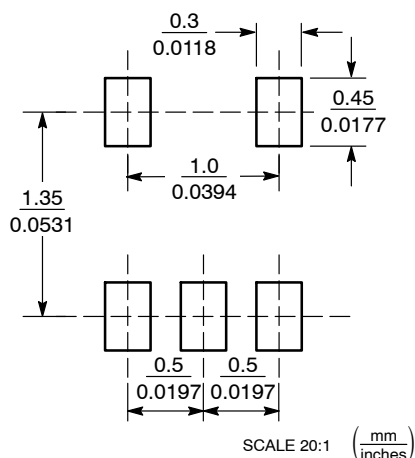


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

| DIM | MILLIMETERS |      |      | INCHES    |       |       |
|-----|-------------|------|------|-----------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN       | NOM   | MAX   |
| A   | 0.50        | 0.55 | 0.60 | 0.020     | 0.022 | 0.024 |
| b   | 0.17        | 0.22 | 0.27 | 0.007     | 0.009 | 0.011 |
| c   | 0.08        | 0.13 | 0.18 | 0.003     | 0.005 | 0.007 |
| D   | 1.55        | 1.60 | 1.65 | 0.061     | 0.063 | 0.065 |
| E   | 1.15        | 1.20 | 1.25 | 0.045     | 0.047 | 0.049 |
| e   | 0.50 BSC    |      |      | 0.020 BSC |       |       |
| L   | 0.10        | 0.20 | 0.30 | 0.004     | 0.008 | 0.012 |
| H_E | 1.55        | 1.60 | 1.65 | 0.061     | 0.063 | 0.065 |

#### RECOMMENDED SOLDERING FOOTPRINT\*



#### GENERIC MARKING DIAGRAM\*



XX = Specific Device Code  
M = Date Code  
■ = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

#### STYLE 1:

- PIN 1. BASE  
2. EMITTER  
3. BASE  
4. COLLECTOR  
5. COLLECTOR

#### STYLE 2:

- PIN 1. CATHODE  
2. COMMON ANODE  
3. CATHODE 2  
4. CATHODE 3  
5. CATHODE 4

#### STYLE 3:

- PIN 1. ANODE 1  
2. N/C  
3. ANODE 2  
4. CATHODE 2  
5. CATHODE 1

#### STYLE 4:

- PIN 1. SOURCE 1  
2. DRAIN 1/2  
3. SOURCE 1  
4. GATE 1  
5. GATE 2

#### STYLE 5:

- PIN 1. ANODE  
2. EMITTER  
3. BASE  
4. COLLECTOR  
5. CATHODE

#### STYLE 6:

- PIN 1. EMITTER 2  
2. BASE 2  
3. EMITTER 1  
4. COLLECTOR 1  
5. COLLECTOR 2/BASE 1

#### STYLE 7:

- PIN 1. BASE  
2. EMITTER  
3. BASE  
4. COLLECTOR  
5. COLLECTOR


#### STYLE 8:

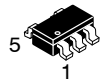
- PIN 1. CATHODE  
2. COLLECTOR  
3. N/C  
4. BASE  
5. EMITTER

#### STYLE 9:

- PIN 1. ANODE  
2. CATHODE  
3. ANODE  
4. ANODE  
5. ANODE

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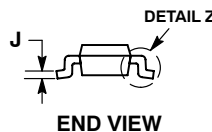
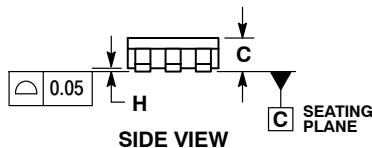
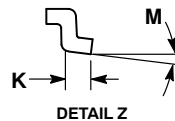
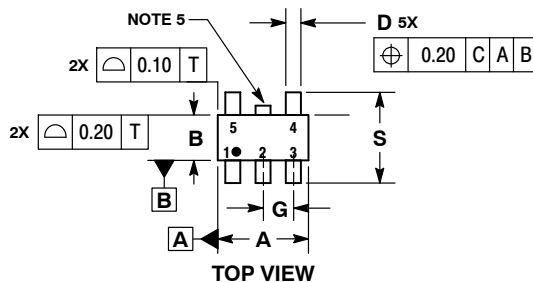
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SCALE 2:1

### TSOP-5 CASE 483 ISSUE N

DATE 12 AUG 2020

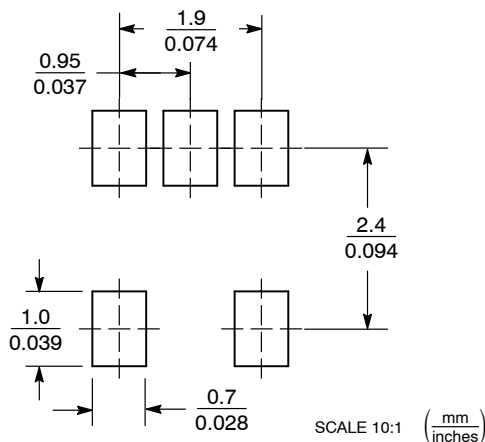


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE. DIMENSION A.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

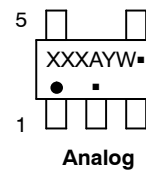
| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 2.85        | 3.15 |
| B   | 1.35        | 1.65 |
| C   | 0.90        | 1.10 |
| D   | 0.25        | 0.50 |
| G   | 0.95 BSC    |      |
| H   | 0.01        | 0.10 |
| J   | 0.10        | 0.26 |
| K   | 0.20        | 0.60 |
| M   | 0°          | 10°  |
| S   | 2.50        | 3.00 |

#### SOLDERING FOOTPRINT\*

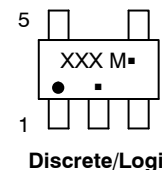


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

#### GENERIC MARKING DIAGRAM\*



Analog



Discrete/Logic

XXX = Specific Device Code  
 A = Assembly Location  
 Y = Year  
 W = Work Week  
 ■ = Pb-Free Package

XXX = Specific Device Code  
 M = Date Code  
 ■ = Pb-Free Package

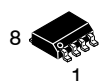
(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present.

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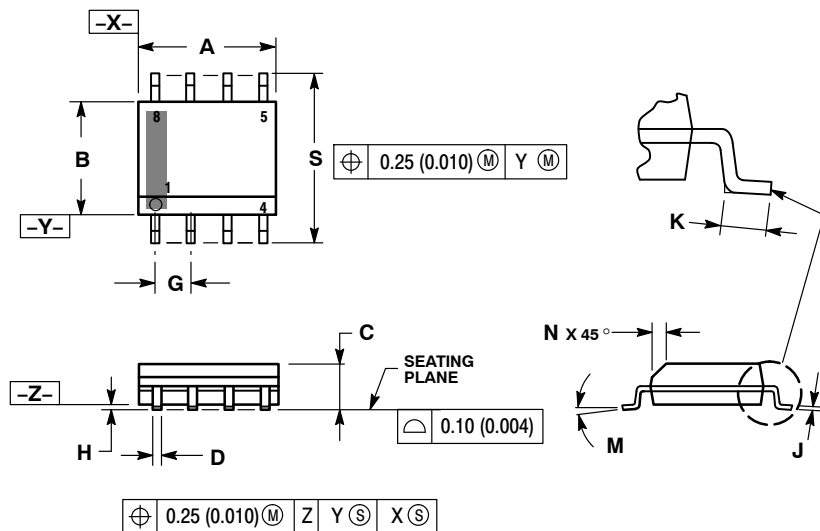
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-8 NB  
CASE 751-07  
ISSUE AK

DATE 16 FEB 2011

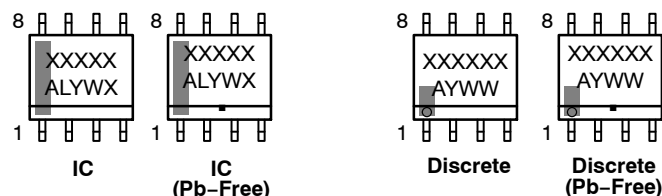
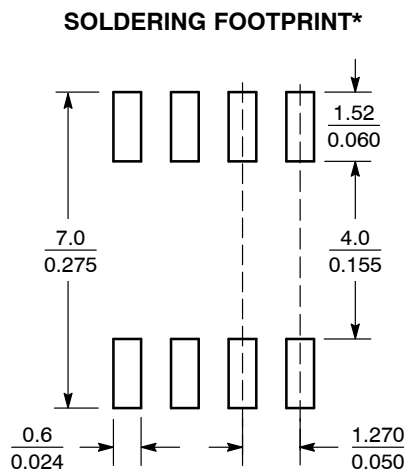


## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.80        | 5.00 | 0.189     | 0.197 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.053     | 0.069 |
| D   | 0.33        | 0.51 | 0.013     | 0.020 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| H   | 0.10        | 0.25 | 0.004     | 0.010 |
| J   | 0.19        | 0.25 | 0.007     | 0.010 |
| K   | 0.40        | 1.27 | 0.016     | 0.050 |
| M   | 0°          | 8°   | 0°        | 8°    |
| N   | 0.25        | 0.50 | 0.010     | 0.020 |
| S   | 5.80        | 6.20 | 0.228     | 0.244 |

## GENERIC MARKING DIAGRAM\*



XXXXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
■ = Pb-Free Package

XXXXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

STYLES ON PAGE 2

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**SOIC-8 NB**  
**CASE 751-07**  
**ISSUE AK**

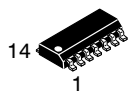
DATE 16 FEB 2011

|   |  |  |  |
|---|--|--|--|
| <b>STYLE 1:</b><br>PIN 1. EMITTER<br>2. COLLECTOR<br>3. COLLECTOR<br>4. EMITTER<br>5. EMITTER<br>6. BASE<br>7. BASE<br>8. EMITTER   | <b>STYLE 2:</b><br>PIN 1. COLLECTOR, DIE, #1<br>2. COLLECTOR, #1<br>3. COLLECTOR, #2<br>4. COLLECTOR, #2<br>5. BASE, #2<br>6. EMITTER, #2<br>7. BASE, #1<br>8. EMITTER, #1               | <b>STYLE 3:</b><br>PIN 1. DRAIN, DIE #1<br>2. DRAIN, #1<br>3. DRAIN, #2<br>4. DRAIN, #2<br>5. GATE, #2<br>6. SOURCE, #2<br>7. GATE, #1<br>8. SOURCE, #1                            | <b>STYLE 4:</b><br>PIN 1. ANODE<br>2. ANODE<br>3. ANODE<br>4. ANODE<br>5. ANODE<br>6. ANODE<br>7. ANODE<br>8. COMMON CATHODE   |
| <b>STYLE 5:</b><br>PIN 1. DRAIN<br>2. DRAIN<br>3. DRAIN<br>4. DRAIN<br>5. GATE<br>6. GATE<br>7. SOURCE<br>8. SOURCE   | <b>STYLE 6:</b><br>PIN 1. SOURCE<br>2. DRAIN<br>3. DRAIN<br>4. SOURCE<br>5. SOURCE<br>6. GATE<br>7. GATE<br>8. SOURCE  | <b>STYLE 7:</b><br>PIN 1. INPUT<br>2. EXTERNAL BYPASS<br>3. THIRD STAGE SOURCE<br>4. GROUND<br>5. DRAIN<br>6. GATE 3<br>7. SECOND STAGE Vd<br>8. FIRST STAGE Vd                    | <b>STYLE 8:</b><br>PIN 1. COLLECTOR, DIE #1<br>2. BASE, #1<br>3. BASE, #2<br>4. COLLECTOR, #2<br>5. COLLECTOR, #2<br>6. EMITTER, #2<br>7. EMITTER, #1<br>8. COLLECTOR, #1                              |
| <b>STYLE 9:</b><br>PIN 1. EMITTER, COMMON<br>2. COLLECTOR, DIE #1<br>3. COLLECTOR, DIE #2<br>4. EMITTER, COMMON<br>5. EMITTER, COMMON<br>6. BASE, DIE #2<br>7. BASE, DIE #1<br>8. EMITTER, COMMON | <b>STYLE 10:</b><br>PIN 1. GROUND<br>2. BIAS 1<br>3. OUTPUT<br>4. GROUND<br>5. GROUND<br>6. BIAS 2<br>7. INPUT<br>8. GROUND  | <b>STYLE 11:</b><br>PIN 1. SOURCE 1<br>2. GATE 1<br>3. SOURCE 2<br>4. GATE 2<br>5. DRAIN 2<br>6. DRAIN 2<br>7. DRAIN 1<br>8. DRAIN 1   | <b>STYLE 12:</b><br>PIN 1. SOURCE<br>2. SOURCE<br>3. SOURCE<br>4. GATE<br>5. DRAIN<br>6. DRAIN<br>7. DRAIN<br>8. DRAIN   |
| <b>STYLE 13:</b><br>PIN 1. N.C.<br>2. SOURCE<br>3. SOURCE<br>4. GATE<br>5. DRAIN<br>6. DRAIN<br>7. DRAIN<br>8. DRAIN  | <b>STYLE 14:</b><br>PIN 1. N-SOURCE<br>2. N-GATE<br>3. P-SOURCE<br>4. P-GATE<br>5. P-DRAIN<br>6. P-DRAIN<br>7. N-DRAIN<br>8. N-DRAIN   | <b>STYLE 15:</b><br>PIN 1. ANODE 1<br>2. ANODE 1<br>3. ANODE 1<br>4. ANODE 1<br>5. CATHODE, COMMON<br>6. CATHODE, COMMON<br>7. CATHODE, COMMON<br>8. CATHODE, COMMON               | <b>STYLE 16:</b><br>PIN 1. EMITTER, DIE #1<br>2. BASE, DIE #1<br>3. EMITTER, DIE #2<br>4. BASE, DIE #2<br>5. COLLECTOR, DIE #2<br>6. COLLECTOR, DIE #2<br>7. COLLECTOR, DIE #1<br>8. COLLECTOR, DIE #1 |
| <b>STYLE 17:</b><br>PIN 1. VCC<br>2. V2OUT<br>3. V1OUT<br>4. TXE<br>5. RXE<br>6. VEE<br>7. GND<br>8. ACC  | <b>STYLE 18:</b><br>PIN 1. ANODE<br>2. ANODE<br>3. SOURCE<br>4. GATE<br>5. DRAIN<br>6. DRAIN<br>7. CATHODE<br>8. CATHODE   | <b>STYLE 19:</b><br>PIN 1. SOURCE 1<br>2. GATE 1<br>3. SOURCE 2<br>4. GATE 2<br>5. DRAIN 2<br>6. MIRROR 2<br>7. DRAIN 1<br>8. MIRROR 1   | <b>STYLE 20:</b><br>PIN 1. SOURCE (N)<br>2. GATE (N)<br>3. SOURCE (P)<br>4. GATE (P)<br>5. DRAIN<br>6. DRAIN<br>7. DRAIN<br>8. DRAIN   |
| <b>STYLE 21:</b><br>PIN 1. CATHODE 1<br>2. CATHODE 2<br>3. CATHODE 3<br>4. CATHODE 4<br>5. CATHODE 5<br>6. COMMON ANODE<br>7. COMMON ANODE<br>8. CATHODE 6  | <b>STYLE 22:</b><br>PIN 1. I/O LINE 1<br>2. COMMON CATHODE/VCC<br>3. COMMON CATHODE/VCC<br>4. I/O LINE 3<br>5. COMMON ANODE/GND<br>6. I/O LINE 4<br>7. I/O LINE 5<br>8. COMMON ANODE/GND | <b>STYLE 23:</b><br>PIN 1. LINE 1 IN<br>2. COMMON ANODE/GND<br>3. COMMON ANODE/GND<br>4. LINE 2 IN<br>5. LINE 2 OUT<br>6. COMMON ANODE/GND<br>7. COMMON ANODE/GND<br>8. LINE 1 OUT | <b>STYLE 24:</b><br>PIN 1. BASE<br>2. EMITTER<br>3. COLLECTOR/ANODE<br>4. COLLECTOR/ANODE<br>5. CATHODE<br>6. CATHODE<br>7. COLLECTOR/ANODE<br>8. COLLECTOR/ANODE                                      |
| <b>STYLE 25:</b><br>PIN 1. VIN<br>2. N/C<br>3. REXT<br>4. GND<br>5. IOUT<br>6. IOUT<br>7. IOUT<br>8. IOUT   | <b>STYLE 26:</b><br>PIN 1. GND<br>2. dv/dt<br>3. ENABLE<br>4. ILIMIT<br>5. SOURCE<br>6. SOURCE<br>7. SOURCE<br>8. VCC  | <b>STYLE 27:</b><br>PIN 1. ILIMIT<br>2. OVLO<br>3. UVLO<br>4. INPUT+<br>5. SOURCE<br>6. SOURCE<br>7. SOURCE<br>8. DRAIN  | <b>STYLE 28:</b><br>PIN 1. SW_TO_GND<br>2. DASIC_OFF<br>3. DASIC_SW_DET<br>4. GND<br>5. V_MON<br>6. VBULK<br>7. VBULK<br>8. VIN  |
| <b>STYLE 29:</b><br>PIN 1. BASE, DIE #1<br>2. EMITTER, #1<br>3. BASE, #2<br>4. EMITTER, #2<br>5. COLLECTOR, #2<br>6. COLLECTOR, #2<br>7. COLLECTOR, #1<br>8. COLLECTOR, #1                        | <b>STYLE 30:</b><br>PIN 1. DRAIN 1<br>2. DRAIN 1<br>3. GATE 2<br>4. SOURCE 2<br>5. SOURCE 1/DRAIN 2<br>6. SOURCE 1/DRAIN 2<br>7. SOURCE 1/DRAIN 2<br>8. GATE 1                           |  |  |

|                         |                    |   |
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| <b>DESCRIPTION:</b>     | <b>SOIC-8 NB</b>   | <b>PAGE 2 OF 2</b>  |

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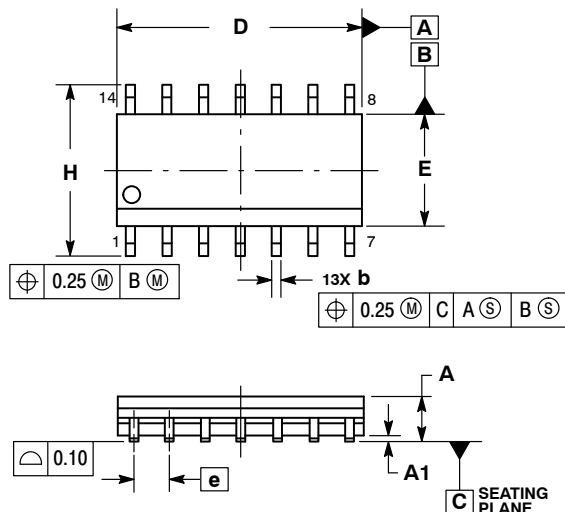
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-14 NB  
CASE 751A-03  
ISSUE L

DATE 03 FEB 2016

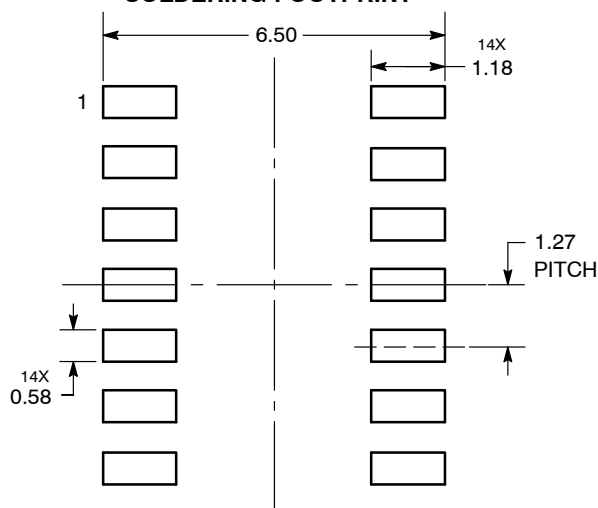


## NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 1.35        | 1.75 | 0.054     | 0.068 |
| A1  | 0.10        | 0.25 | 0.004     | 0.010 |
| A3  | 0.19        | 0.25 | 0.008     | 0.010 |
| b   | 0.35        | 0.49 | 0.014     | 0.019 |
| D   | 8.55        | 8.75 | 0.337     | 0.344 |
| E   | 3.80        | 4.00 | 0.150     | 0.157 |
| e   | 1.27 BSC    |      | 0.050 BSC |       |
| H   | 5.80        | 6.20 | 0.228     | 0.244 |
| h   | 0.25        | 0.50 | 0.010     | 0.019 |
| L   | 0.40        | 1.25 | 0.016     | 0.049 |
| M   | 0°          | 7°   | 0°        | 7°    |

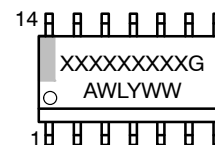
## SOLDERING FOOTPRINT\*



DIMENSIONS: MILLIMETERS

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## GENERIC MARKING DIAGRAM\*



XXXXXX = Specific Device Code  
A = Assembly Location  
WL = Wafer Lot  
Y = Year  
WW = Work Week  
G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

|                  |             |   |
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| DESCRIPTION:     | SOIC-14 NB  | PAGE 1 OF 2   |

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SOIC-14  
CASE 751A-03  
ISSUE L

DATE 03 FEB 2016

STYLE 1:  
PIN 1. COMMON CATHODE  
2. ANODE/CATHODE  
3. ANODE/CATHODE  
4. NO CONNECTION  
5. ANODE/CATHODE  
6. NO CONNECTION  
7. ANODE/CATHODE  
8. ANODE/CATHODE  
9. ANODE/CATHODE  
10. NO CONNECTION  
11. ANODE/CATHODE  
12. ANODE/CATHODE  
13. NO CONNECTION  
14. COMMON ANODE

STYLE 2:  
CANCELLED

STYLE 3:  
PIN 1. NO CONNECTION  
2. ANODE  
3. ANODE  
4. NO CONNECTION  
5. ANODE  
6. NO CONNECTION  
7. ANODE  
8. ANODE  
9. ANODE  
10. NO CONNECTION  
11. ANODE  
12. ANODE  
13. NO CONNECTION  
14. COMMON CATHODE

STYLE 4:  
PIN 1. NO CONNECTION  
2. CATHODE  
3. CATHODE  
4. NO CONNECTION  
5. CATHODE  
6. NO CONNECTION  
7. CATHODE  
8. CATHODE  
9. CATHODE  
10. NO CONNECTION  
11. CATHODE  
12. CATHODE  
13. NO CONNECTION  
14. COMMON ANODE

STYLE 5:  
PIN 1. COMMON CATHODE  
2. ANODE/CATHODE  
3. ANODE/CATHODE  
4. ANODE/CATHODE  
5. ANODE/CATHODE  
6. NO CONNECTION  
7. COMMON ANODE  
8. COMMON CATHODE  
9. ANODE/CATHODE  
10. ANODE/CATHODE  
11. ANODE/CATHODE  
12. ANODE/CATHODE  
13. NO CONNECTION  
14. COMMON ANODE

STYLE 6:  
PIN 1. CATHODE  
2. CATHODE  
3. CATHODE  
4. CATHODE  
5. CATHODE  
6. CATHODE  
7. CATHODE  
8. ANODE  
9. ANODE  
10. ANODE  
11. ANODE  
12. ANODE  
13. ANODE  
14. ANODE

STYLE 7:  
PIN 1. ANODE/CATHODE  
2. COMMON ANODE  
3. COMMON CATHODE  
4. ANODE/CATHODE  
5. ANODE/CATHODE  
6. ANODE/CATHODE  
7. ANODE/CATHODE  
8. ANODE/CATHODE  
9. ANODE/CATHODE  
10. ANODE/CATHODE  
11. COMMON CATHODE  
12. COMMON ANODE  
13. ANODE/CATHODE  
14. ANODE/CATHODE

STYLE 8:  
PIN 1. COMMON CATHODE  
2. ANODE/CATHODE  
3. ANODE/CATHODE  
4. NO CONNECTION  
5. ANODE/CATHODE  
6. ANODE/CATHODE  
7. COMMON ANODE  
8. COMMON ANODE  
9. ANODE/CATHODE  
10. ANODE/CATHODE  
11. NO CONNECTION  
12. ANODE/CATHODE  
13. ANODE/CATHODE  
14. COMMON CATHODE

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| DESCRIPTION:     | SOIC-14 NB  | PAGE 2 OF 2   |

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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

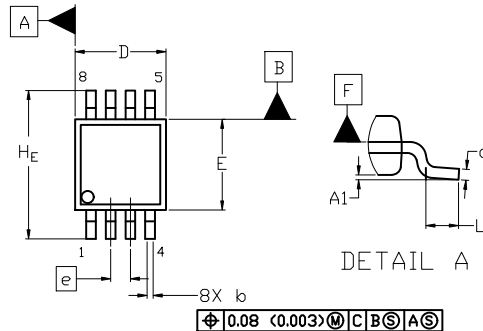
ON Semiconductor®



SCALE 2:1

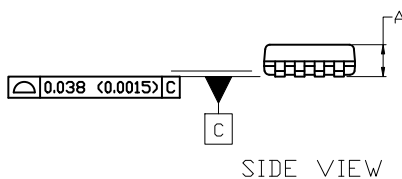
## Micro8 CASE 846A-02 ISSUE K

DATE 16 JUL 2020

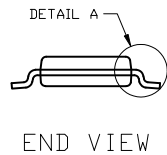


TOP VIEW

NOTE 3

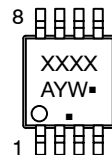


SIDE VIEW



END VIEW

### GENERIC MARKING DIAGRAM\*



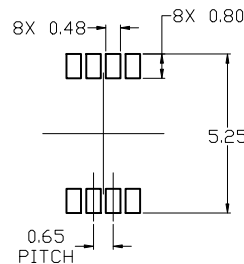
XXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION  $b$  DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.10 mm IN EXCESS OF MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS  $D$  AND  $E$  DO NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 mm PER SIDE. DIMENSION  $E$  DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 mm PER SIDE. DIMENSIONS  $D$  AND  $E$  ARE DETERMINED AT DATUM  $F$ .
5. DATUMS  $A$  AND  $B$  ARE TO BE DETERMINED AT DATUM  $F$ .
6.  $A1$  IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.



### RECOMMENDED MOUNTING FOOTPRINT

For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, [SOLDERM-10](#).

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | ---         | ---  | 1.10 |
| A1  | 0.05        | 0.08 | 0.15 |
| b   | 0.25        | 0.33 | 0.40 |
| c   | 0.13        | 0.18 | 0.23 |
| D   | 2.90        | 3.00 | 3.10 |
| E   | 2.90        | 3.00 | 3.10 |
| e   | 0.65 BSC    |      |      |
| HE  | 4.75        | 4.90 | 5.05 |
| L   | 0.40        | 0.55 | 0.70 |

### STYLE 1:

- PIN 1. SOURCE
- SOURCE
- SOURCE
- GATE
- DRAIN
- DRAIN
- DRAIN
- DRAIN

### STYLE 2:

- PIN 1. SOURCE 1
- GATE 1
- SOURCE 2
- GATE 2
- DRAIN 2
- DRAIN 2
- DRAIN 1
- DRAIN 1

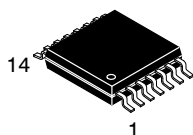
### STYLE 3:

- PIN 1. N-SOURCE
- N-GATE
- P-SOURCE
- P-GATE
- P-DRAIN
- P-DRAIN
- N-DRAIN
- N-DRAIN

|                  |             |   |
|------------------|-------------|---|
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| DESCRIPTION:     | MICRO8      | PAGE 1 OF 1   |

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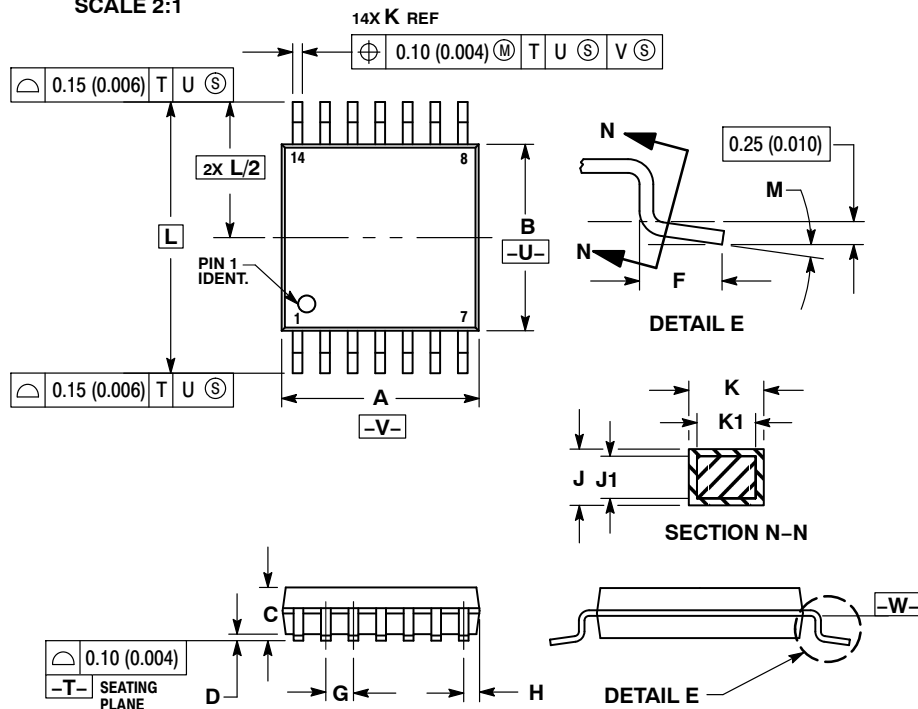
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



**TSSOP-14 WB**  
CASE 948G  
ISSUE C

DATE 17 FEB 2016

SCALE 2:1

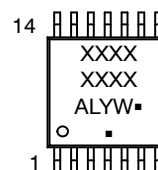


## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.90        | 5.10 | 0.193     | 0.200 |
| B   | 4.30        | 4.50 | 0.169     | 0.177 |
| C   | ---         | 1.20 | ---       | 0.047 |
| D   | 0.05        | 0.15 | 0.002     | 0.006 |
| F   | 0.50        | 0.75 | 0.020     | 0.030 |
| G   | 0.65 BSC    |      | 0.026 BSC |       |
| H   | 0.50        | 0.60 | 0.020     | 0.024 |
| J   | 0.09        | 0.20 | 0.004     | 0.008 |
| J1  | 0.09        | 0.16 | 0.004     | 0.006 |
| K   | 0.19        | 0.30 | 0.007     | 0.012 |
| K1  | 0.19        | 0.25 | 0.007     | 0.010 |
| L   | 6.40 BSC    |      | 0.252 BSC |       |
| M   | 0°          | 8°   | 0°        | 8°    |

## GENERIC MARKING DIAGRAM\*

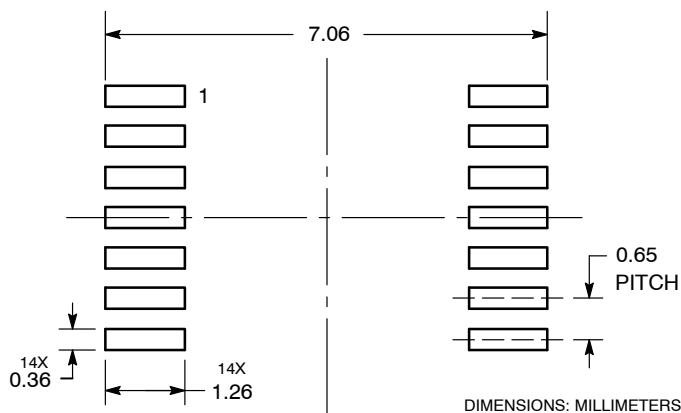


- A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

## SOLDERING FOOTPRINT



DOCUMENT NUMBER: 98ASH70246A

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DESCRIPTION: TSSOP-14 WB

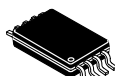
PAGE 1 OF 1

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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®

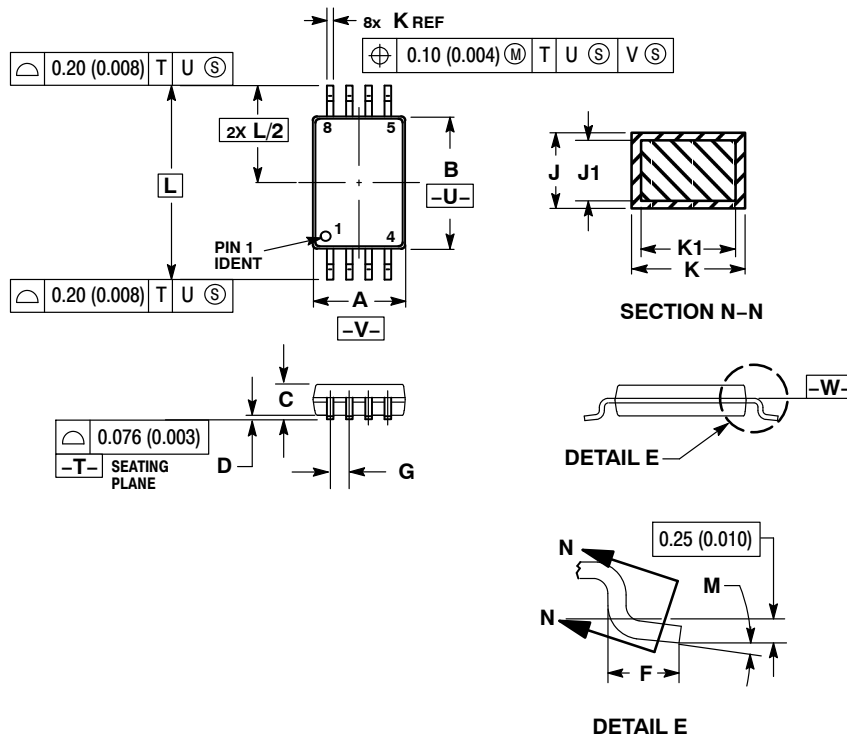
ON



SCALE 2:1

**TSSOP-8**  
CASE 948S-01  
ISSUE C

DATE 20 JUN 2008

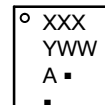


## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
6. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 2.90        | 3.10 | 0.114     | 0.122 |
| B   | 4.30        | 4.50 | 0.169     | 0.177 |
| C   | ---         | 1.10 | ---       | 0.043 |
| D   | 0.05        | 0.15 | 0.002     | 0.006 |
| F   | 0.50        | 0.70 | 0.020     | 0.028 |
| G   | 0.65 BSC    |      | 0.026 BSC |       |
| J   | 0.09        | 0.20 | 0.004     | 0.008 |
| J1  | 0.09        | 0.16 | 0.004     | 0.006 |
| K   | 0.19        | 0.30 | 0.007     | 0.012 |
| K1  | 0.19        | 0.25 | 0.007     | 0.010 |
| L   | 6.40 BSC    |      | 0.252 BSC |       |
| M   | 0°          | 8°   | 0°        | 8°    |

## GENERIC MARKING DIAGRAM\*




XXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present.

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