

**MNCLC409A-X REV 0A0**

Original Creation Date: 08/05/98

Last Update Date: 02/24/99

Last Major Revision Date: 11/12/98

**VERY WIDEBAND, LOW DISTORTION MONOLITHIC OP AMP**
**General Description**

The CLC409 is a very wideband, DC coupled monolithic operational amplifier designed specifically for wide dynamic range systems requiring exceptional signal fidelity. Benefiting from Comlinear's current feedback architecture, the CLC409 offers a gain range of  $\pm 1$  to  $\pm 10$  while providing stable, oscillation free operation without external compensation, even at unity gain.

With its 350MHz small signal bandwidth ( $V_{out} = 2V_{pp}$ ), 10-bit distortion levels through 20MHz ( $R_L = 1000\Omega$ ), 8-bit distortion levels through 60MHz, 2.2nV/SqrtHz input referred noise and 13.5mA supply current, the CLC409 is the ideal driver or buffer for high speed flash A/D and D/A converters.

Wide dynamic range systems such as radar and communication receivers requiring a wideband amplifier offering exceptional signal purity will find the CLC409's low input referred noise and low harmonic and intermodulation distortion make it an attractive high speed solution.

**Industry Part Number**

CLC409A

**NS Part Numbers**

CLC409AE-QML\*\*

CLC409AJ-QML\*

**Prime Die**

UB1927B

**Controlling Document**

5962-9203401MPA\*, M2A\*\*

**Processing**

MIL-STD-883, Method 5004

**Quality Conformance Inspection**

MIL-STD-883, Method 5005

**Subgrp Description Temp (°C)**

|    |                     |      |
|----|---------------------|------|
| 1  | Static tests at     | +25  |
| 2  | Static tests at     | +125 |
| 3  | Static tests at     | -55  |
| 4  | Dynamic tests at    | +25  |
| 5  | Dynamic tests at    | +125 |
| 6  | Dynamic tests at    | -55  |
| 7  | Functional tests at | +25  |
| 8A | Functional tests at | +125 |
| 8B | Functional tests at | -55  |
| 9  | Switching tests at  | +25  |
| 10 | Switching tests at  | +125 |
| 11 | Switching tests at  | -55  |

**Features**

- 350MHz small signal bandwidth
- -65/-72dBc 2nd/3rd harmonics (20MHz)
- Low Noise
- 8ns settling to 0.1%
- 1200V/us slew rate
- 13.5mA supply current ( $\pm 5V$ )
- 70mA output current

**Applications**

- Flash A/D driver
- D/A transimpedance buffer
- Wide dynamic range IF amp
- Radar/communication receivers
- DDS post-amps
- Wideband inverting summer
- Line driver

**(Absolute Maximum Ratings)**

(Note 1)

|                                          |                 |
|------------------------------------------|-----------------|
| Supply Voltage (Vcc)                     | ±7V dc          |
| Common Mode Input Voltage (Vcm)          | ±Vcc            |
| Differential Input Voltage               | +10V dc         |
| Output Current (Io)                      | ±70mA           |
| Power Dissipation (Pd)<br>(Note 2)       | 1.2W            |
| Junction Temperature (Tj)                | +175 C          |
| Lead Temperature (soldering, 10 seconds) | +300 C          |
| Storage Temperature Range                | -65 C to +125 C |
| Thermal Resistance                       |                 |
| ThetaJA (Junction to Ambient)            |                 |
| CERAMIC DIP (Still Air)                  | 132 C/W         |
| (500 LFPM)                               | 77 C/W          |
| LCC (Still Air)                          | 97 C/W          |
| (500 LFPM)                               | 67 C/W          |
| ThetaJC (Junction to Case)               |                 |
| CERAMIC DIP                              | 26 C/W          |
| LCC                                      | 27 C/W          |
| Package Weight<br>(Typical)              |                 |
| CERAMIC DIP                              | 1070 mg         |
| LCC                                      | 465 mg          |
| ESD Tolerance<br>(Note 3)                |                 |
| ESD Rating                               | 500 V           |

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings are conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 2: The maximum power dissipation must be derated at elevated temperatures and is dictated by Tjmax (maximum junction temperature), ThetaJA (package junction to ambient thermal resistance, and TA (ambient temperature). The maximum allowable power dissipation at any temperature is  $P_{dmax} = (T_{jmax} - TA) / \Theta_{JA}$  or the number given in the Absolute Maximum Ratings, whichever is lower.

Note 3: Human body model, 1.5K Ohms in series with 100pF.

## **Recommended Operating Conditions**

|                                          |                     |
|------------------------------------------|---------------------|
| Supply Voltage (Vcc)                     | $\pm 5\text{V}$ dc  |
| Gain Range                               | $\pm 1$ to $\pm 10$ |
| Ambient Operating Temperature Range (Ta) | -55 C to +125 C     |

## Electrical Characteristics

### AC/DC PARAMETERS

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC:  $R_I = 100\ \Omega$ ,  $V_{CC} = \pm 5V$  dc,  $A_V = +2$ , feedback resistor ( $R_f$ ) = 250  $\Omega$ , gain resistor ( $R_g$ ) = 250

AC:  $0\ \Omega$  -55  $^{\circ}C \leq T_a \leq +125\ ^{\circ}C$  (Note 3)

| SYMBOL | PARAMETER                                                         | CONDITIONS                                   | NOTES | PIN-NAME | MIN  | MAX  | UNIT      | SUB-GROUPS |
|--------|-------------------------------------------------------------------|----------------------------------------------|-------|----------|------|------|-----------|------------|
| Ibn    | Input Bias Current, Noninverting                                  |                                              |       |          | -22  | +22  | $\mu A$   | 1, 2       |
|        |                                                                   |                                              |       |          | -44  | +44  | $\mu A$   | 3          |
| DIbn   | Input Bias Current, Average Temperature Coefficient, Noninverting |                                              | 1     |          | -125 | +125 | nA/C      | 2          |
|        |                                                                   |                                              | 1     |          | -275 | +275 | nA/C      | 3          |
| Ibi    | Input Bias Current, Inverting                                     |                                              |       |          | -20  | +20  | $\mu A$   | 1          |
|        |                                                                   |                                              |       |          | -30  | +30  | $\mu A$   | 2          |
|        |                                                                   |                                              |       |          | -36  | +36  | $\mu A$   | 3          |
| DIbi   | Input Bias Current, Average Temperature Coefficient, Inverting    |                                              | 1     |          | -100 | +100 | nA/C      | 2          |
|        |                                                                   |                                              | 1     |          | -200 | +200 | nA/C      | 3          |
| Vio    | Input Offset Voltage                                              |                                              |       |          | -4.5 | +4.5 | mV        | 1          |
|        |                                                                   |                                              |       |          | -9.5 | +9.5 | mV        | 2          |
|        |                                                                   |                                              |       |          | -8.5 | +8.5 | mV        | 3          |
| DVio   | Input Offset Voltage, Average Temperature Coefficient             |                                              | 1     |          | -50  | +50  | $\mu V/C$ | 2          |
|        |                                                                   |                                              | 1     |          | -50  | +50  | $\mu V/C$ | 3          |
| Icc    | Supply Current, no load                                           |                                              |       |          |      | 14.2 | mA        | 1, 2, 3    |
| PSRR   | Power Supply Rejection Ratio                                      | -Vcc = -4.5V to -5.0V, +Vcc = +4.5V to +5.0V |       |          | 45   |      | dB        | 1, 2, 3    |
| +Io    | Output Current                                                    |                                              | 1     |          | +50  |      | mA        | 1, 2       |
|        |                                                                   |                                              | 1     |          | +36  |      | mA        | 3          |
| -Io    | Output Current                                                    |                                              | 1     |          |      | -50  | mA        | 1, 2       |
|        |                                                                   |                                              | 1     |          |      | -36  | mA        | 3          |
| +Vo    | Output Voltage Range                                              |                                              | 1     |          | +3.2 |      | V         | 1, 2       |
|        |                                                                   |                                              | 1     |          | +3.0 |      | V         | 3          |
| -Vo    | Output Voltage Range                                              |                                              | 1     |          |      | -3.2 | V         | 1, 2       |
|        |                                                                   |                                              | 1     |          |      | -3.0 | V         | 3          |

## Electrical Characteristics

### AC/DC PARAMETERS(Continued)

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC:  $R_l = 100\ \Omega$ ,  $V_{cc} = \pm 5V$  dc,  $A_v = +2$ , feedback resistor ( $R_f$ ) = 250  $\Omega$ , gain resistor ( $R_g$ ) = 250

AC:  $0\ \Omega$   $-55\ ^\circ C \leq T_a \leq +125\ ^\circ C$  (Note 3)

| SYMBOL | PARAMETER                      | CONDITIONS                             | NOTES | PIN-NAME | MIN  | MAX | UNIT       | SUB-GROUPS |
|--------|--------------------------------|----------------------------------------|-------|----------|------|-----|------------|------------|
| Rin    | Noninverting Input Resistance  |                                        | 1     |          | 500  |     | K $\Omega$ | 1          |
|        |                                |                                        | 1     |          | 1000 |     | K $\Omega$ | 2          |
|        |                                |                                        | 1     |          | 250  |     | K $\Omega$ | 3          |
| Cin    | Noninverting Input Capacitance |                                        | 1     |          |      | 2   | pF         | 4, 5, 6    |
| Ro     | Output Impedance               |                                        | 1     |          |      | 0.2 | $\Omega$   | 1, 2       |
|        |                                |                                        | 1     |          |      | 0.3 | $\Omega$   | 3          |
| CMRR   | Common Mode Rejection Ratio    | $V_{cm} = \pm 1.0V$                    | 1     |          | 45   |     | dB         | 4, 5, 6    |
| SSBW   | Small Signal Bandwidth         | -3dB bandwidth, $V_{out} < 2V_{pp}$    | 1     |          | 250  |     | MHz        | 4, 6       |
|        |                                |                                        | 1     |          | 200  |     | MHz        | 5          |
| LSBW   | Large Signal Bandwidth         | -3dB bandwidth, $V_{out} < 5V_{pp}$    | 1     |          | 90   |     | MHz        | 4, 6       |
|        |                                |                                        | 1     |          | 80   |     | MHz        | 5          |
| GFPL   | Gain Flatness Peaking          | 0.1MHz to 75MHz, $V_{out} < 0.5V_{pp}$ |       |          |      | 0.4 | dB         | 4          |
|        |                                |                                        | 2     |          |      | 0.4 | dB         | 5, 6       |
| GFPH   | Gain Flatness Peaking          | > 75MHz, $V_{out} < 0.5V_{pp}$         |       |          |      | 0.8 | dB         | 4          |
|        |                                |                                        | 2     |          |      | 0.8 | dB         | 5, 6       |
| GFR1   | Gain Flatness Rolloff          | 0.1MHz to 125MHz                       |       |          |      | 1.0 | dB         | 4          |
|        |                                |                                        | 2     |          |      | 1.0 | dB         | 5, 6       |
| GFR2   | Gain Flatness Rolloff          | At 200MHz                              |       |          |      | 2.2 | dB         | 4          |
|        |                                |                                        | 2     |          |      | 3.0 | dB         | 5          |
|        |                                |                                        | 2     |          |      | 2.0 | dB         | 6          |
| LPD    | Linear Phase Deviation         | .01MHz to 100MHz                       | 1     |          |      | 0.8 | Degree     | 4, 6       |
|        |                                |                                        | 1     |          |      | 1.0 | Degree     | 5          |
| DG     | Differential Gain              | $R_l = 150\ \Omega$ , 3.58MHz, 4.43MHz | 1     |          |      | .06 | %          | 4, 5       |
|        |                                |                                        | 1     |          |      | .07 | %          | 6          |
| DP     | Differential Phase             | $R_l = 150\ \Omega$ , 3.58MHz, 4.43MHz | 1     |          |      | .02 | Degree     | 4, 5, 6    |
| HD2    | 2nd Harmonic Distortion        | 2Vpp at 20MHz                          |       |          |      | -52 | dBc        | 4          |
|        |                                |                                        | 2     |          |      | -52 | dBc        | 5, 6       |

## Electrical Characteristics

### AC/DC PARAMETERS(Continued)

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC:  $R_I = 100\ \Omega$ ,  $V_{CC} = \pm 5V$  dc,  $A_v = +2$ , feedback resistor ( $R_f$ ) = 250  $\Omega$ , gain resistor ( $R_g$ ) = 250

AC:  $0\ \text{Ohms}$   $-55\ ^\circ\text{C} \leq T_a \leq +125\ ^\circ\text{C}$  (Note 3)

| SYMBOL | PARAMETER                                    | CONDITIONS                                                         | NOTES | PIN-NAME | MIN  | MAX  | UNIT     | SUB-GROUPS |
|--------|----------------------------------------------|--------------------------------------------------------------------|-------|----------|------|------|----------|------------|
| HD2L   | 2nd Harmonic Distortion                      | 2Vpp at 5MHz                                                       | 1     |          |      | -81  | dBc      | 4, 5       |
|        |                                              |                                                                    | 1     |          |      | -78  | dBc      | 6          |
| HD2H   | 2nd Harmonic Distortion                      | 2Vpp at 60MHz                                                      | 1     |          |      | -44  | dBc      | 4, 5       |
|        |                                              |                                                                    | 1     |          |      | -41  | dBc      | 6          |
| HD3    | 3rd Harmonic Distortion                      | 2Vpp at 20MHz                                                      |       |          |      | -65  | dBc      | 4          |
|        |                                              |                                                                    | 2     |          |      | -65  | dBc      | 5, 6       |
| HD3L   | 3rd Harmonic Distortion                      | 2Vpp at 5MHz                                                       | 1     |          |      | -76  | dBc      | 4, 5, 6    |
| HD3H   | 3rd Harmonic Distortion                      | 2Vpp at 60MHz                                                      | 1     |          |      | -52  | dBc      | 4, 5, 6    |
| Trs    | Rise and Fall Time                           | 2V step, $C_l < 10\text{pF}$ , measured between 10% and 90% points | 1     |          |      | 1.6  | ns       | 9, 10, 11  |
| Trl    | Rise and Fall Time                           | 5V step, $C_l < 10\text{pF}$ , measured between 10% and 90% points | 1     |          |      | 4.2  | ns       | 9, 11      |
|        |                                              |                                                                    | 1     |          |      | 4.6  | ns       | 10         |
| Ts     | Settling Time                                | $C_l < 10\text{pF}$ , 2V step at 0.1% of the final value           | 1     |          |      | 12   | ns       | 9, 10, 11  |
| OS     | Overshoot                                    | 2V step, $C_l < 10\text{pF}$                                       | 1     |          |      | 18   | %        | 9, 10      |
|        |                                              |                                                                    | 1     |          |      | 15   | %        | 11         |
| SR     | Slew Rate                                    | $V_{out} = 4V$ step, $C_l < 10\text{pF}$ , measured at $\pm 1V$    | 1     |          | 1000 |      | V/us     | 4, 5, 6    |
| VN     | Equivalent Input Noise, Noninverting Voltage | > 1MHz                                                             | 1     |          |      | 2.8  | nV/Sq Rt | 4, 6       |
|        |                                              |                                                                    | 1     |          |      | 3.1  | nV/Sq Rt | 5          |
| ICN    | Equivalent Input Noise, Inverting Current    | > 1MHz                                                             | 1     |          |      | 18   | pA/Sq Rt | 4, 6       |
|        |                                              |                                                                    | 1     |          |      | 20   | pA/Sq Rt | 5          |
| NCN    | Equivalent Input Noise, Noninverting Current | > 1MHz                                                             | 1     |          |      | 4.0  | pA/Sq Rt | 4, 6       |
|        |                                              |                                                                    | 1     |          |      | 4.5  | pA/Sq Rt | 5          |
| SNF    | Equivalent Input Noise, Total Noise Floor    | > 1MHz                                                             | 1     |          |      | -155 | dBm 1Hz  | 4, 6       |
|        |                                              |                                                                    | 1     |          |      | -154 | dBm 1Hz  | 5          |

## Electrical Characteristics

### AC/DC PARAMETERS(Continued)

(The following conditions apply to all the following parameters, unless otherwise specified.)

DC:  $R_I = 100\ \Omega$ ,  $V_{CC} = \pm 5V$  dc,  $A_v = +2$ , feedback resistor ( $R_f$ ) = 250  $\Omega$ , gain resistor ( $R_g$ ) = 250

AC:  $\Omega$ ms  $-55\ ^\circ C \leq T_a \leq +125\ ^\circ C$  (Note 3)

| SYMBOL | PARAMETER                                      | CONDITIONS     | NOTES | PIN-NAME | MIN | MAX | UNIT    | SUB-GROUPS |
|--------|------------------------------------------------|----------------|-------|----------|-----|-----|---------|------------|
| INV    | Equivalent Input Noise, Total Integrated Noise | 1MHz to 150MHz | 1     |          |     | 47  | $\mu V$ | 4, 6       |
|        |                                                |                | 1     |          |     | 52  | $\mu V$ | 5          |

Note 1: Guaranteed, if not tested.

Note 2: This parameter is group A sample tested only and is excluded from final electrical testing, but is guaranteed to the limits specified.

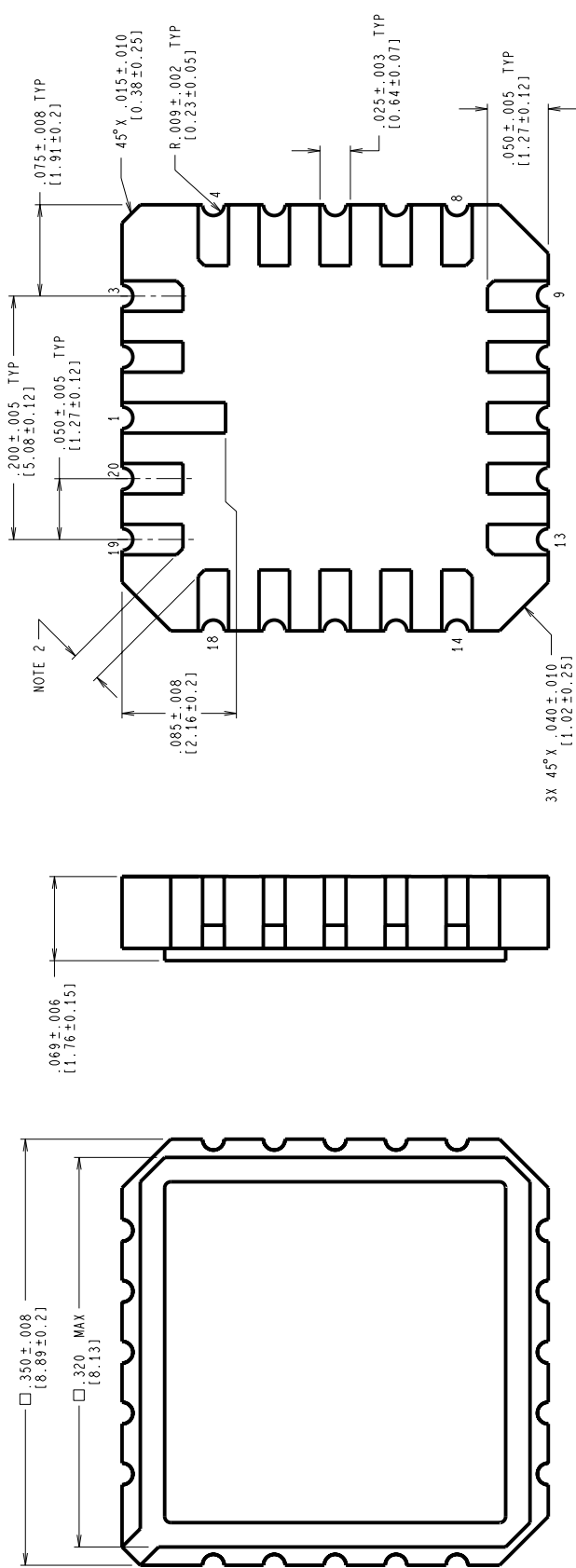
Note 3: The algebraic convention, whereby the most negative value is a minimum and most positive is a maximum, is used in this table. Negative current shall be defined as conventional current flow out of a device terminal.

## Graphics and Diagrams

| GRAPHICS# | DESCRIPTION                            |
|-----------|----------------------------------------|
| 07077HRA2 | CERDIP (J), 8 LEAD (B/I CKT)           |
| 07086HRA2 | LCC (E), TYPE C, 20 TERMINAL (B/I CKT) |
| E20ARE    | LCC (E), TYPE C, 20 TERMINAL (P/P DWG) |
| J08ARL    | CERDIP (J), 8 LEAD (P/P DWG)           |
| P000406A  | CERDIP (J), 8 LEAD (PINOUT)            |
| P000446A  | LCC (E), TYPE C, 20 TERMINAL (PINOUT)  |

See attached graphics following this page.

| REVISIONS |                   |        |               |
|-----------|-------------------|--------|---------------|
| LTR       | DESCRIPTION       | E.C.N. | DATE          |
| E         | REVISE AND REDRAW | 10005  | 02/10/94 DEG/ |



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

NOTES: UNLESS OTHERWISE SPECIFIED.

1. LEAD FINISH TO BE ONE OF THE FOLLOWING:

- 50 MICRONS/12.7 MICROMETERS MINIMUM GOLD PLATING OVER 50-350 MICRONS/1.27-8.89 MICROMETERS NICKEL.
  - SOLDER DIP.
  - SOLDER THICKNESS PER LATEST REVISION OF MIL-STD-1835.
2. CORNER PADS MAY HAVE A  $45^\circ$  X  $.020$  IN/0.51mm MAXIMUM CHAMFER TO ACCOMPLISH THE .015 IN/0.38mm DIMENSION.
4. REFERENCE JEDEC REGISTRATION MS-004, VARIATION CB, DATED 7/90.

# MIL/AERO CONFIGURATION CONTROL

| APPROVALS  |              | DATE     | SCALE        |   | SIZE    | DRAWING NUMBER |              | REV |
|------------|--------------|----------|--------------|---|---------|----------------|--------------|-----|
| DESIGN     | Design Grady | 02/10/94 | N/A          | C | C       | MKT-E20A       | E            | E   |
| ESTD       | CHK          |          |              |   |         |                |              |     |
| ENGR       | CHK          |          |              |   |         |                |              |     |
| APPROVAL   |              |          |              |   |         |                |              |     |
| PROJECTION |              |          | DO NOT SCALE |   | DRAWING |                | SHEET 1 of 1 |     |

**NATIONAL SEMICONDUCTOR CORPORATION**  
2000 Semiconductor Drive, Santa Clara, CA 95052-8000

**LEADLESS CHIP CARRIER,  
TYPE C,  
20 TERMINAL**





CLC409J

8 - LEAD DIP

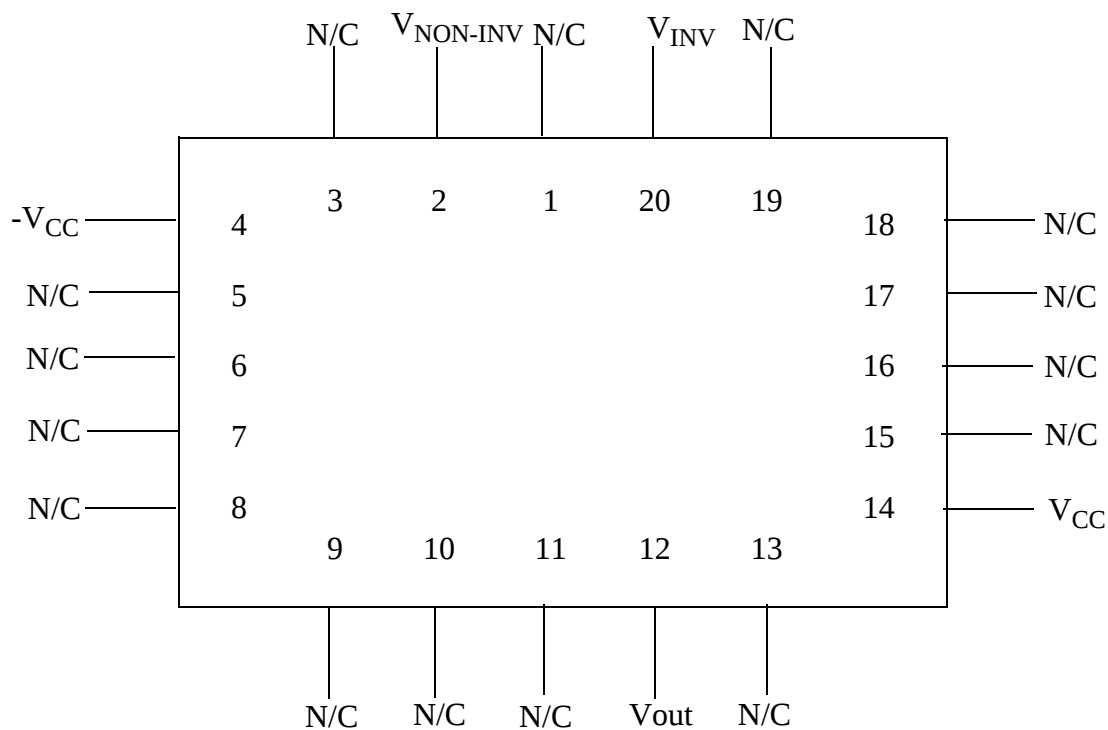
CONNECTION DIAGRAM

TOP VIEW

P000406A



National Semiconductor™  
MIL/AEROSPACE OPERATIONS  
2900 SEMICONDUCTOR DRIVE  
SANTA CLARA, CA 95050



CLC409E  
 20 - LEAD LCC  
 CONNECTION DIAGRAM  
 TOP VIEW  
 P000446A



National Semiconductor™  
 MIL/AEROSPACE OPERATIONS  
 2900 SEMICONDUCTOR DRIVE  
 SANTA CLARA, CA 95050

**Revision History**

| <b>Rev</b> | <b>ECN #</b> | <b>Rel Date</b> | <b>Originator</b> | <b>Changes</b>      |
|------------|--------------|-----------------|-------------------|---------------------|
| 0A0        | M0003257     | 02/24/99        | Shaw Mead         | Initial MDS Release |