

# Matched quad high-performance low-voltage operational amplifier

NE/SA5234

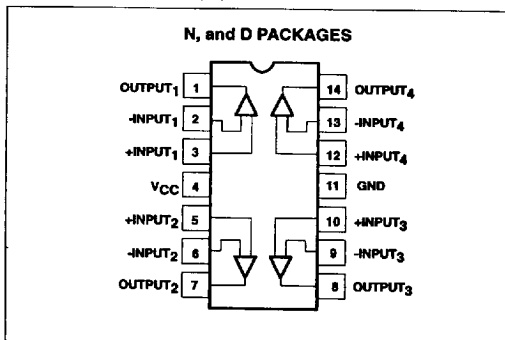
## DESCRIPTION

The NE/SA5234 is a matched, low voltage, high performance quad operational amplifier. Among its unique input and output characteristics is the capability for both input and output rail-to-rail operation, particularly critical in low voltage applications. The output swings to less than 50mV of both rails across the entire power supply range. The NE/SA5234 is capable of delivering 5.5V peak-to-peak across a 600Ω load and will typically draw only 700μA per amplifier. The bandwidth is 2.5MHz and the 1% settling time is 1.4μs.

## FEATURES

- Wide common-mode input voltage range: 250mV beyond both rails
- Output swing within 50mV of both rails
- Functionality to 1.8V typical
- Low current consumption: 700μA per amplifier
- ±15mA output current capability
- Unity gain bandwidth: 2.5MHz
- Slew rate: 0.8V/μs
- Low noise: 25nV/√Hz
- Electrostatic discharge protection
- Short-circuit protection
- Output inversion prevention

## PIN CONFIGURATION



## APPLICATIONS

- Automotive electronics
- Signal conditioning and sensing amplification
- Portable instrumentation
  - Test and measurement
  - Medical monitors and diagnostics
  - Remote meters
- Audio equipment
- Security systems
- Communications
  - Pagers
  - Cellular telephone
  - LAN
  - 5V Dacom bus
- Error amplifier in motor drives
- Transducer buffer amplifier

## ORDERING INFORMATION

| DESCRIPTION                               | TEMPERATURE RANGE | ORDER CODE | DWG # |
|-------------------------------------------|-------------------|------------|-------|
| 14-Pin Plastic Small Outline (SO) package | 0 to +70°C        | NE5234D    | 0175D |
| 14-Pin Plastic Dual In-Line Package (DIP) | 0 to +70°C        | NE5234N    | 0405B |
| 14-Pin Plastic Small Outline (SO) package | -40 to +85°C      | SA5234D    | 0175D |
| 14-Pin Plastic Dual In-Line Package (DIP) | -40 to +85°C      | SA5234N    | 0405B |

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## ABSOLUTE MAXIMUM RATINGS

| SYMBOL        | PARAMETER                                                                             | RATING         | UNITS |
|---------------|---------------------------------------------------------------------------------------|----------------|-------|
| $V_{CC}$      | Single supply voltage                                                                 | 7              | V     |
| $V_{ESD}$     | ESD protection voltage at any pin <sup>5</sup><br>human body model<br>robot model     | 2000           | V     |
|               |                                                                                       | 200            | V     |
|               |                                                                                       |                | V     |
| $V_S$         | Dual supply voltage                                                                   | $\pm 3.5$      | V     |
| $V_{DP}$      | Voltage at any device pin <sup>1</sup>                                                | $V_S \pm 0.5$  | V     |
| $I_{DP}$      | Current into any device pin <sup>1</sup>                                              | $\pm 50$       | mA    |
| $V_{IN}$      | Differential input voltage <sup>2</sup>                                               | 0.5            | V     |
| $V_{CM}$      | Common-mode input voltage (positive)                                                  | $V_{CC} + 0.5$ | V     |
| $V_{CM}$      | Common-mode input voltage (negative)                                                  | $V_{EE} - 0.5$ | V     |
| $P_D$         | Power dissipation <sup>3</sup>                                                        | 500            | mW    |
| $T_J$         | Operating junction temperature <sup>3</sup>                                           | +150           | °C    |
| $V_{SC}$      | Supply voltage allowing indefinite output short circuit to either rail <sup>3,4</sup> | 7              | V     |
| $T_{STG}$     | Storage temperature range                                                             | -65 to +150    | °C    |
| $T_{SOLD}$    | Lead soldering temperature (10sec max)                                                | +300           | °C    |
| $\theta_{JA}$ | Thermal impedance                                                                     |                |       |
|               | 14 pin Plastic DIP                                                                    | 80             | °C/W  |
|               | 14 pin Plastic SO                                                                     | 115            | °C/W  |

### NOTES:

- Each pin is protected by ESD diodes. The voltage at any pin is limited by the ESD diodes.
- The differential input of each amplifier is limited by two internal diodes, connected in parallel and opposite to each other. For more differential input range, use differential resistors in series with the input pins.
- The maximum operating junction temperature is +150°C. At elevated temperatures, devices must be derated according to the package thermal resistance and device mounting conditions. Derates above +25°C: F package at 6.7mW/°C; N package at 9.5mW/°C; D package at 6.25mW/°C.
- Simultaneous short circuits of two or more amplifiers to the positive or negative rail can exceed the power dissipation ratings and cause eventual destruction of the device.
- Guaranteed by design.

## RECOMMENDED OPERATING CONDITIONS

| SYMBOL   | PARAMETER                            | RATING                | UNITS |
|----------|--------------------------------------|-----------------------|-------|
| $V_{CC}$ | Single supply voltage                | +2 to +5.5            | V     |
| $V_S$    | Dual supply voltage                  | $\pm 1$ to $\pm 2.75$ | V     |
| $V_{CM}$ | Common-mode input voltage (positive) | $V_{CC} + 0.25$       | V     |
| $V_{CM}$ | Common-mode input voltage (negative) | $V_{EE} - 0.25$       | V     |
| $T_A$    | Temperature                          |                       |       |
|          | NE                                   | 0 to +70              | °C    |
|          | SA                                   | -40 to +85            | °C    |

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## DC ELECTRICAL CHARACTERISTICS

$V_{CC} = 2$  to  $5.5V$ ,  $V_{EE} = 0V$ ,  $T_A = 25^\circ C$ ;  $V_{EE} < V_{CM} < V_{CC}$ ; unless otherwise stated.

| SYMBOL                      | PARAMETER                                                                                                       | TEST CONDITIONS                                            | LIMITS                |      |                       |                       |      |                       | UNITS |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------|------|-----------------------|-----------------------|------|-----------------------|-------|
|                             |                                                                                                                 |                                                            | NE5234                |      |                       | SA5234                |      |                       |       |
|                             |                                                                                                                 |                                                            | MIN                   | TYP  | MAX                   | MIN                   | TYP  | MAX                   |       |
| I <sub>CC</sub>             | Supply current                                                                                                  | V <sub>CC</sub> = 5.5V                                     |                       | 2.8  | 4.0                   |                       | 2.8  | 4.0                   | mA    |
|                             |                                                                                                                 | V <sub>CC</sub> = 5.5V over full temperature range         |                       | 3.0  | 4.6                   |                       | 3.2  | 4.8                   |       |
| V <sub>OS</sub>             | Offset voltage                                                                                                  |                                                            |                       | ±0.2 | ±4                    |                       | ±0.2 | ±4                    | mV    |
|                             |                                                                                                                 | Over full temperature range                                |                       | ±0.4 | ±5                    |                       | ±0.6 | ±5                    |       |
| ΔV <sub>OS</sub> /ΔT        | Offset voltage drift with temperature                                                                           |                                                            |                       | 4    |                       |                       | 4    |                       | μV/°C |
| ΔV <sub>OS</sub>            | Offset voltage difference between any amplifiers in the same package at the same common mode level <sup>1</sup> |                                                            |                       | 0.4  | 3                     |                       | 0.4  | 3                     | mV    |
|                             |                                                                                                                 | Over full temperature range                                |                       | 0.8  | 4                     |                       | 1.2  | 4                     |       |
| I <sub>OS</sub>             | Offset current                                                                                                  |                                                            |                       | ±3   | ±20                   |                       | ±3   | ±30                   | nA    |
|                             |                                                                                                                 | Over full temperature range                                |                       | ±4   | ±30                   |                       | ±6   | ±60                   |       |
| ΔI <sub>OS</sub> /ΔT        | Offset current drift with temperature                                                                           |                                                            |                       | 0.02 | ±3                    |                       | 0.03 | ±3                    | nA/°C |
| I <sub>B</sub>              | Input bias current <sup>1</sup>                                                                                 | V <sub>EE</sub> < V <sub>CM</sub> < V <sub>EE</sub> +0.5V  | -200                  | -90  |                       | -200                  | -90  |                       | nA    |
|                             |                                                                                                                 | Over full temperature range                                | -225                  | -100 |                       | -250                  | -150 |                       |       |
|                             |                                                                                                                 | V <sub>EE</sub> +1V < V <sub>CM</sub> < V <sub>CC</sub>    |                       | 25   | 70                    |                       | 25   | 75                    |       |
|                             |                                                                                                                 | Over full temperature range                                |                       | 35   | 100                   |                       | 35   | 120                   |       |
| ΔI <sub>B</sub> /ΔT         | Input bias current drift with temperature                                                                       |                                                            |                       | 0.5  |                       |                       | 0.5  |                       | nA/°C |
| ΔI <sub>B</sub>             | Input bias current difference between any amplifier in the same package at the same common mode level.          | V <sub>EE</sub> < V <sub>CM</sub> < V <sub>EE</sub> +0.5V  |                       | 10   | 30                    |                       | 10   | 30                    | nA    |
|                             |                                                                                                                 | Over full temperature range                                |                       | 25   | 50                    |                       | 50   | 70                    |       |
|                             |                                                                                                                 | V <sub>EE</sub> +1V < V <sub>CM</sub> < V <sub>CC</sub>    |                       | 5    | 20                    |                       | 5    | 20                    |       |
|                             |                                                                                                                 | Over full temperature range                                |                       | 15   | 30                    |                       | 25   | 50                    |       |
| V <sub>CM</sub>             | Common-mode input range                                                                                         | V <sub>OS</sub> ≤ 6mV                                      | V <sub>EE</sub> -0.25 |      | V <sub>CC</sub> +0.25 | V <sub>EE</sub> -0.25 |      | V <sub>CC</sub> +0.25 | V     |
|                             |                                                                                                                 | V <sub>OS</sub> ≤ 6mV over full temperature range          | V <sub>EE</sub> -0.1  |      | V <sub>CC</sub> +0.1  | V <sub>EE</sub> -0.1  |      | V <sub>CC</sub> +0.1  |       |
| CMRR                        | Common-mode rejection ratio, small signal                                                                       | V <sub>EE</sub> < V <sub>CM</sub> < V <sub>EE</sub> +0.5V, |                       | 100  |                       | 90                    | 100  |                       | dB    |
|                             |                                                                                                                 | V <sub>EE</sub> +1V < V <sub>CM</sub> < V <sub>CC</sub>    |                       |      |                       |                       |      |                       |       |
|                             | Over full temperature range                                                                                     |                                                            | 100                   |      | 80                    | 90                    |      |                       |       |
|                             | Common-mode rejection ratio, large signal                                                                       | V <sub>EE</sub> < V <sub>CM</sub> < V <sub>CC</sub>        |                       | 90   |                       |                       | 100  |                       |       |
| Over full temperature range |                                                                                                                 |                                                            | 80                    |      |                       | 90                    |      |                       |       |
| PSRR                        | Power supply rejection ratio                                                                                    | V <sub>EE</sub> < V <sub>CM</sub> < V <sub>CC</sub>        | 80                    | 100  |                       | 80                    | 100  |                       | dB    |
|                             |                                                                                                                 | Over full temperature range                                | 80                    | 90   |                       | 80                    | 90   |                       |       |

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## DC ELECTRICAL CHARACTERISTICS (continued)

| DC ELECTRICAL CHARACTERISTICS (continued) |                                                                             |                                              |               |     |               |               |     |               |       |
|-------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------|---------------|-----|---------------|---------------|-----|---------------|-------|
| SYMBOL                                    | PARAMETER                                                                   | TEST CONDITIONS                              | LIMITS        |     |               |               |     |               | UNITS |
|                                           |                                                                             |                                              | NE5234        |     |               | SA5234        |     |               |       |
|                                           |                                                                             |                                              | MIN           | TYP | MAX           | MIN           | TYP | MAX           |       |
| $I_L$                                     | Peak load current, sink and source                                          |                                              | 10            | 12  |               | 10            | 12  |               | mA    |
|                                           |                                                                             | Over full temperature range                  | 5             | 8   |               | 5             | 8   |               |       |
| $A_{VOL}$                                 | Open-loop voltage gain                                                      |                                              | 90            | 110 |               | 90            | 110 |               | dB    |
|                                           |                                                                             | Over full temperature range                  |               | 90  |               |               | 90  |               |       |
| $V_{OUT}$                                 | Output voltage swing                                                        | $I_{PEAK} = 0.1\text{mA}$                    | $V_{EE}+0.05$ |     | $V_{CC}-0.05$ | $V_{EE}+0.1$  |     | $V_{CC}-0.1$  | V     |
|                                           |                                                                             | $I_{PEAK} = 10\text{mA}$                     | $V_{EE}+0.25$ |     | $V_{CC}-0.25$ | $V_{EE}+0.25$ |     | $V_{CC}-0.25$ |       |
|                                           |                                                                             | $I_{PEAK} = 5\text{mA}$ over full temp range | $V_{EE}+0.22$ |     | $V_{CC}-0.2$  | $V_{EE}+0.2$  |     | $V_{CC}-0.2$  |       |
|                                           | Output voltage swing for $V_{CC} = 2.75\text{V}$ , $V_{EE} = -2.75\text{V}$ | $R_L = 2\text{k}\Omega$                      | $V_{EE}+0.2$  |     | $V_{CC}-0.2$  | $V_{EE}+0.2$  |     | $V_{CC}-0.2$  | V     |
|                                           |                                                                             | $R_L = 600\Omega$                            | $V_{EE}+0.25$ |     | $V_{CC}-0.25$ | $V_{EE}+0.25$ |     | $V_{CC}-0.25$ |       |

### NOTES:

- These parameters are measured for  $V_{EE} < V_{CM} < V_{EE}+5\text{V}$  and for  $V_{EE}+1\text{V} < V_{CM} < V_{CC}$ . By design these parameters are intermediate for common mode ranges between the measured regions.

## AC ELECTRICAL CHARACTERISTICS

$T_A = +25^\circ\text{C}$ ;  $V_{CC} = 2$  to  $5.5\text{V}$ ;  $R_L = 10\text{k}\Omega$ ;  $C_L = 100\text{pF}$ ; unless otherwise stated.

| A <sub>V</sub> = +25 °C, V <sub>CC</sub> = 2 to 5.5V, R <sub>L</sub> = 10k, C <sub>L</sub> = 100pF, unless otherwise stated. |                              |                                                  |        |     |     |           |     |     |                      |
|------------------------------------------------------------------------------------------------------------------------------|------------------------------|--------------------------------------------------|--------|-----|-----|-----------|-----|-----|----------------------|
| SYMBOL                                                                                                                       | PARAMETER                    | TEST CONDITIONS                                  | LIMITS |     |     |           |     |     | UNITS                |
|                                                                                                                              |                              |                                                  | NE5234 |     |     | SA/SE5234 |     |     |                      |
|                                                                                                                              |                              |                                                  | MIN    | TYP | MAX | MIN       | TYP | MAX |                      |
| SR                                                                                                                           | Slew rate                    | Over full temperature range                      | 0.5    | 0.8 |     | 0.5       | 0.8 |     | V/μs                 |
| BW                                                                                                                           | Unity gain bandwidth: -3dB   | Over full temperature range                      | 2      | 2.5 | 4.0 | 2         | 2.5 | 4.0 | MHz                  |
| θ <sub>M</sub>                                                                                                               | Phase Margin                 | C <sub>L</sub> = 50pF                            |        | 55  |     |           | 55  |     | deg                  |
| t <sub>S</sub>                                                                                                               | 1% settling time             | A <sub>V</sub> = 1, 1V step                      |        | 1.4 |     |           | 1.4 |     | μs                   |
| V <sub>N</sub>                                                                                                               | Input referred voltage noise | A <sub>V</sub> = 1, R <sub>S</sub> = 0Ω, at 1kHz |        | 25  |     |           | 25  |     | nV/Hz <sup>1/2</sup> |
| THD                                                                                                                          | Total harmonic distortion    | 10kHz, 1V <sub>P-P</sub> , A <sub>V</sub> = 1    |        | 0.1 |     |           | 0.1 |     | %                    |

## OUTPUT INVERSION PREVENTION

