# NTE992
# Integrated Circuit
# Quad, Single Supply Operational Amplifier

## Description:

The NTE992 is an internally compensated Norton operational amplifier in a 14–Lead DIP type package designed specifically for single positive power supply applications found in industrial control systems and automotive electronics. This device contains four independent amplifiers – making it ideal for applications such as active filters, multi–channel amplifiers, tachometers, oscillators, and other similar usages.

## Features:

- Single–Supply Operation
- Internally Compensated
- Wide Unity Gain Bandwidth: 4MHz Typ
- Low Input Bias Current: 50nA Typ
- High Open–Loop Gain: 1000V/V Min
- Large Output Voltage Swing: $(V_{CC} -1)$ $V_{P-P}$

## Absolute Maximum Ratings:

Supply Voltage, $V_{CC}$ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 28V

Input Currents ($I_{in}+$ or $I_{in}-$), $I_{in}$ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5mA

Output Current, $I_O$ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 50mA

Power Dissipation ($T_A$ = +25°C), $P_D$ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 625mW

      Derate Above 25°C . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5mW/°C

Operating Ambient Temperature, $T_A$ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . –40° to +85°C

Storage Temperature Range, $T_{stg}$ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . –65° to +150°C

## Electrical Characteristics: ($T_A$ = +25°C, $V_{CC}$ = +15V unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Open–Loop Voltage Gain | $A_{VOL}$ | f = 100Hz, $R_L$ = 5kΩ, Note 1 | 1.2 | 2.0 | – | V/mV |
| Input Resistance (Inverting Input) | $r_i$ | | – | 1.0 | – | MΩ |
| Output Resistance | $r_O$ | | – | 8.0 | – | kΩ |
| Input Bias Current (Inverting Input) | $I_{IB}$ | | – | 50 | 300 | nA |

Note 1. Open–loop voltage gain is defined as voltage gain from the inverting input to the output.

## Electrical Characteristics (Cont'd): ($T_A$ = +25°C, $V_{CC}$ = +15V unless otherwise specified)

| Parameter | Symbol | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Slew Rate<br>    Positive Output Swing | SR | $C_L$ = 100pF, $R_L$ = 2kΩ | | – | 0.5 | – | V/μs |
|     Negative Output Swing | | | | – | 20 | – | V/μs |
| Unity Gain Bandwidth | BW | | | – | 4.0 | – | MHz |
| Output Voltage Swing (Note 6) | $V_{OH}$ | $V_{CC}$ = +15V, $R_L$ = 2kΩ | $V_{out}$ High ($I_{in}$– = 0, $I_{in}$+ = 0 | 13.5 | 14.2 | – | V |
| | $V_{OL}$ | | $V_{out}$ Low ($I_{in}$– = 10μA, $I_{in}$+ = 0 | – | 0.03 | 0.2 | V |
| | $V_{OH}$ | $V_{CC}$ = Max Rating, $R_L$ = ∞,<br>$V_{out}$ High ($I_{in}$– = 0, $I_{in}$+ = 0) | | – | 25.5 | – | V |
| Output Current<br>    Source | $I_{source}$ | | | 5.0 | 10.0 | – | mA |
|     Sink (Note 2) | $I_{sink}$ | | | 0.5 | 0.87 | – | mA |
|     Low Level Output Current | $I_{OL}$ | $I_{in}$– = 5μA, $V_{OL}$ = 1V | | – | 5.0 | – | mA |
| Supply Current (All Four Amps)<br>    Non–Inverting Inputs Open | $I_{DO}$ | | | – | 6.9 | 10.0 | mA |
|     Non–Inverting Inputs Grounded | $I_{DG}$ | | | – | 7.8 | 14.0 | mA |
| Power Supply Rejection | PSRR | f = 100Hz | | – | 55 | – | dB |
| Mirror Gain | $A_i$ | $I_{in}$+ = 20μA | $T_A$ = –40° to +85°C, Note 3 | 0.90 | 1.0 | 1.1 | μA |
| | | $I_{in}$+ = 200μA | | 0.90 | 1.0 | 1.1 | μA |
| Δ Mirror Gain | $\Delta A_i$ | 20μA ≤ $I_{in}$+ ≤ 200μA, $T_A$ = –40° to +85°C,<br>Note 3 | | – | 2.0 | 5.0 | % |
| Mirror Current | | $T_A$ = –40° to +85°C | | – | 10 | 500 | μA |
| Negative Input Current | | Note 5 | | – | 1.0 | – | mA |

Note  2. Sink current is specified for linear operation.  When the device is used as a comparator (non–linear operation) where the inverting input is overdriven, the sink current (low level output current) capability is typically 5mA.

Note  3. This specification indicates the current gain of the current mirror which is used as the non–inverting input.

Note  4. Input $V_{BE}$ match between the non–inverting and inverting inputs occurs for a mirror current (non–inverting input current) of approximately 10μA.

Note  5. Clamp transistors are included to prevent the input voltages from swinging below GND more than approximately –0.3V.  The negative input currents that may result from large signal overdrive with capacitance input coupling must be limited externally to values of approximately 1mA.  Negative input currents in excess of 4mA will cause the output to drop to a low voltage. These values apply for any one of the input terminals.  If more than one of the input terminals are simultaneously driven negative, maximum currents are reduced.  Common–mode biasing can be used to prevent negative input voltages.

Note  6. When used as a non–inverting amplifier, the minimum output voltage is the $V_{BE}$ of the inverting input transistor.

**Pin Connection Diagram**

| Left | Pin | | Pin | Right |
|---|---|---|---|---|
| (+) Input B | 1 | | 14 | V (+) |
| (+) Input A | 2 | | 13 | (+) Input C |
| (−) Input A | 3 | | 12 | (+) Input D |
| Output A | 4 | | 11 | (−) Input D |
| Output B | 5 | | 10 | Output D |
| (−) Input B | 6 | | 9 | Output C |
| GND | 7 | | 8 | (−) Input C |

14                    8

1                    7

.785 (19.95) Max

.300 (7.62)

.200 (5.08) Max

.100 (2.45)

.099 (2.5) Min

.600 (15.24)