



## Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

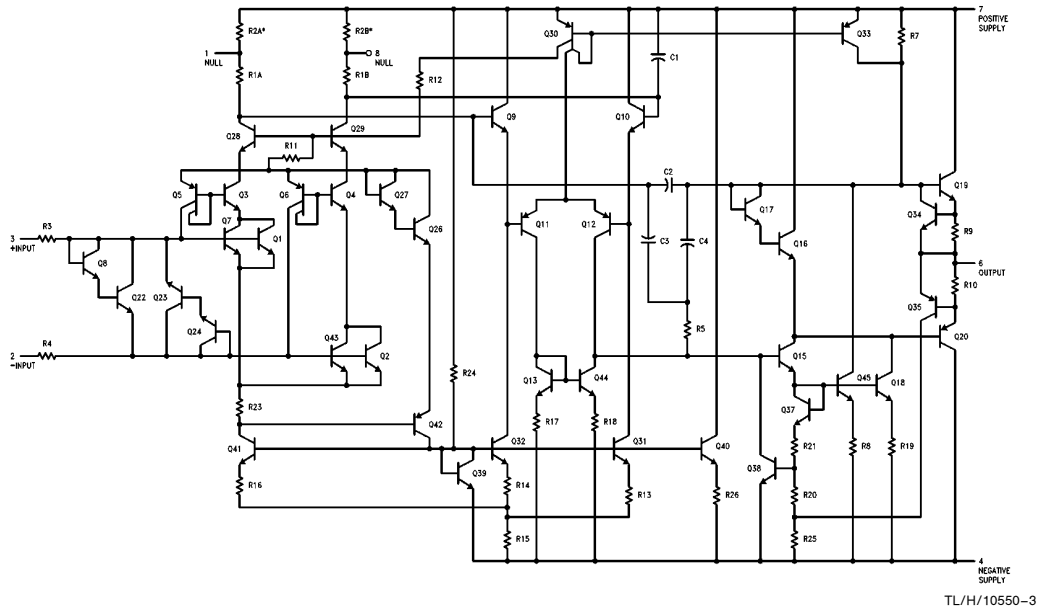
|                                     |                  |
|-------------------------------------|------------------|
| Supply Voltage                      | $\pm 22\text{V}$ |
| Internal Power Dissipation (Note 5) | 500 mW           |
| Differential Input Voltage          | $\pm 30\text{V}$ |
| Input Voltage (Note 6)              | $\pm 22\text{V}$ |
| Output Short-Circuit Duration       | Continuous       |

|                                       |                                                 |
|---------------------------------------|-------------------------------------------------|
| Storage Temperature Range             | $-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |
| Lead Temperature (Soldering, 60 sec.) | $260^{\circ}\text{C}$                           |
| Junction Temperature                  | $-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |

## Operating Temperature Range

|                        |                                              |
|------------------------|----------------------------------------------|
| OP-07E, OP-07C, OP-07D | $0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$ |
|------------------------|----------------------------------------------|

## Simplified Schematic



\*R2A and R2B are electronically trimmed on chip at the factory for minimum offset voltage.

## Electrical Characteristics

Unless otherwise specified,  $V_S = \pm 15V$ ,  $T_A = 25^\circ C$ . **Boldface** type refers to limits over  $0^\circ C \leq T_A \leq 70^\circ C$

| Symbol             | Parameter                                                | Conditions                                                                                                                             | OP-07E                                                      |                                                             |                               | OP-07C                                        |                                                             |                               | Units            |
|--------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------|-----------------------------------------------|-------------------------------------------------------------|-------------------------------|------------------|
|                    |                                                          |                                                                                                                                        | Min                                                         | Typ                                                         | Max                           | Min                                           | Typ                                                         | Max                           |                  |
| $V_{OS}$           | Input Offset Voltage                                     | (Note 1)                                                                                                                               |                                                             | 30<br><b>45</b>                                             | 75<br><b>130</b>              |                                               | 60<br><b>85</b>                                             | 150<br><b>250</b>             | $\mu V$          |
| $V_{OS/t}$         | Long-Term $V_{OS}$ Stability                             | (Note 2)                                                                                                                               |                                                             | 0.3                                                         | 1.5                           |                                               | 0.4                                                         | 2.0                           | $\mu V/Mo$       |
| $I_{OS}$           | Input Offset Current                                     |                                                                                                                                        |                                                             | 0.5<br><b>0.9</b>                                           | 3.8<br><b>5.3</b>             |                                               | 0.8<br><b>1.6</b>                                           | 6.0<br><b>8.0</b>             | nA               |
| $I_B$              | Input Bias Current                                       |                                                                                                                                        |                                                             | $\pm 1.2$<br>$\pm$ <b>1.5</b>                               | $\pm 4.0$<br>$\pm$ <b>5.5</b> |                                               | $\pm 1.8$<br>$\pm$ <b>2.2</b>                               | $\pm 7.0$<br>$\pm$ <b>9.0</b> | nA               |
| $e_{np-p}$         | Input Noise Voltage                                      | 0.1 Hz to 10 Hz (Note 3)                                                                                                               |                                                             | 0.35                                                        | 0.6                           |                                               | 0.38                                                        | 0.65                          | $\mu V_{p-p}$    |
| $e_n$              | Input Noise Voltage Density                              | $f_O = 10$ Hz<br>$f_O = 100$ Hz (Note 3)<br>$f_O = 1000$ Hz                                                                            |                                                             | 10.3<br>10.0<br>9.6                                         | 18.0<br>13.0<br>11.0          |                                               | 10.5<br>10.2<br>9.8                                         | 20.0<br>13.5<br>11.5          | $nV/\sqrt{Hz}$   |
| $i_{np-p}$         | Input Noise Current                                      | 0.1 Hz to 10 Hz (Note 3)                                                                                                               |                                                             | 14                                                          | 30                            |                                               | 15                                                          | 35                            | $pA_{p-p}$       |
| $i_n$              | Input Noise Current Density                              | $f_O = 10$ Hz<br>$f_O = 100$ Hz (Note 3)<br>$f_O = 1000$ Hz                                                                            |                                                             | 0.32<br>0.14<br>0.12                                        | 0.80<br>0.23<br>0.17          |                                               | 0.35<br>0.15<br>0.13                                        | 0.90<br>0.27<br>0.18          | $pA/\sqrt{Hz}$   |
| $R_{IN}$           | Input Resistance Differential-Mode                       | (Note 4)                                                                                                                               | 15                                                          | 50                                                          |                               | 8                                             | 33                                                          |                               | $M\Omega$        |
| $R_{INCM}$         | Input Resistance Common-Mode                             |                                                                                                                                        |                                                             | 160                                                         |                               |                                               | 120                                                         |                               | $G\Omega$        |
| IVR                | Input Voltage Range                                      |                                                                                                                                        | $\pm 13.0$                                                  | $\pm 14.0$                                                  |                               | $\pm 13$                                      | $\pm 14$                                                    |                               | V                |
| CMRR               | Common-Mode Rejection Ratio                              | $V_{CM} = \pm 13V$                                                                                                                     | 106<br><b>103</b>                                           | 123<br><b>123</b>                                           |                               | 100<br><b>97</b>                              | 120<br><b>120</b>                                           |                               | dB               |
| PSRR               | Power Supply Rejection Ratio                             | $V_S = \pm 3V$ to $\pm 18V$<br>$V_S = \pm 3V$ to $\pm 18V$                                                                             |                                                             | 5<br><b>7</b>                                               | 20<br><b>32</b>               |                                               | 7<br><b>10</b>                                              | 32<br><b>51</b>               | $\mu V/V$        |
| $A_{VO}$           | Large Signal Voltage Gain                                | $R_L \geq 2 k\Omega$ , $V_O = \pm 10V$<br>$R_L \geq 2 k\Omega$<br>$R_L \geq 500\Omega$ , $V_O = \pm 0.5V$ ,<br>$V_S = \pm 3V$ (Note 4) | 200<br><b>180</b><br>150                                    | 500<br><b>450</b><br>400                                    |                               | 120<br><b>100</b><br>100                      | 400<br><b>400</b><br>400                                    |                               | V/mV             |
| $V_O$              | Output Voltage Swing                                     | $R_L \geq 10 k\Omega$<br>$R_L \geq 2 k\Omega$<br>$R_L \geq 2 k\Omega$<br>$R_L \geq 1 k\Omega$                                          | $\pm 12.5$<br>$\pm 12.0$<br>$\pm$ <b>12.0</b><br>$\pm 10.5$ | $\pm 13.0$<br>$\pm 12.8$<br>$\pm$ <b>12.6</b><br>$\pm 12.0$ |                               | $\pm 12.0$<br>$\pm 11.5$<br>$\pm$ <b>11.0</b> | $\pm 13.0$<br>$\pm 12.8$<br>$\pm$ <b>12.6</b><br>$\pm 12.0$ |                               | V                |
| SR                 | Slew Rate                                                | $R_L \geq 2 k\Omega$ (Note 3)                                                                                                          | 0.1                                                         | 0.3                                                         |                               | 0.1                                           | 0.3                                                         |                               | $V/\mu s$        |
| BW                 | Closed-Loop Bandwidth                                    | $A_{VCL} = +1$ (Note 3)                                                                                                                | 0.4                                                         | 0.6                                                         |                               | 0.4                                           | 0.6                                                         |                               | MHz              |
| $R_O$              | Output Resistance                                        | $V_O = 0$ , $I_O = 0$                                                                                                                  |                                                             | 60                                                          |                               |                                               | 60                                                          |                               | $\Omega$         |
| $P_d$              | Power Consumption                                        | $V_S = \pm 15V$ , No Load<br>$V_S = \pm 3V$ , No Load                                                                                  |                                                             | 75<br>4                                                     | 120<br>6                      |                                               | 80<br>4                                                     | 150<br>8                      | mW               |
|                    | Offset Adj. Range                                        | $R_P = 20 k\Omega$                                                                                                                     |                                                             | $\pm 4$                                                     |                               |                                               | $\pm 4$                                                     |                               | mV               |
| TCV <sub>OS</sub>  | Average Input Offset Voltage Drift Without External Trim | (Note 4)                                                                                                                               |                                                             | <b>0.3</b>                                                  | <b>1.3</b>                    |                                               | <b>0.5</b>                                                  | <b>1.8</b>                    | $\mu V/^\circ C$ |
| TCV <sub>OSn</sub> | With External Trim                                       | $R_P = 20 k\Omega$ (Note 4)                                                                                                            |                                                             | <b>0.3</b>                                                  | <b>1.3</b>                    |                                               | <b>0.4</b>                                                  | <b>1.6</b>                    |                  |
| TCI <sub>OS</sub>  | Average Input Offset Current Drift                       | (Note 3)                                                                                                                               |                                                             | <b>8</b>                                                    | <b>35</b>                     |                                               | <b>12</b>                                                   | <b>50</b>                     | $pA/^\circ C$    |
| TCI <sub>B</sub>   | Average Input Bias Current Drift                         | (Note 3)                                                                                                                               |                                                             | <b>13</b>                                                   | <b>35</b>                     |                                               | <b>18</b>                                                   | <b>50</b>                     | $pA/^\circ C$    |

## Electrical Characteristics

Unless otherwise specified,  $V_S = \pm 15V$ ,  $T_A = 25^\circ C$ . **Boldface** type refers to limits over  $0^\circ C \leq T_A \leq +70^\circ C$

| Symbol      | Parameter                                                | Conditions                                                                                                                                          | OP-07D                                        |                                                             |                                 | Units            |
|-------------|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-------------------------------------------------------------|---------------------------------|------------------|
|             |                                                          |                                                                                                                                                     | Min                                           | Typ                                                         | Max                             |                  |
| $V_{OS}$    | Input Offset Voltage                                     | (Note 1)                                                                                                                                            |                                               | 60<br><b>85</b>                                             | 150<br><b>250</b>               | $\mu V$          |
| $V_{OS}/t$  | Long-Term $V_{OS}$ Stability                             | (Note 2)                                                                                                                                            |                                               | 0.5                                                         | 3.0                             | $\mu V/Mo$       |
| $I_{OS}$    | Input Offset Current                                     |                                                                                                                                                     |                                               | 0.8<br><b>1.6</b>                                           | 6.0<br><b>8.0</b>               | nA               |
| $I_B$       | Input Bias Current                                       |                                                                                                                                                     |                                               | $\pm 2.0$<br>$\pm$ <b>3.0</b>                               | $\pm 12.0$<br>$\pm$ <b>14.0</b> | nA               |
| $e_{np-p}$  | Input Noise Voltage                                      | 0.1 Hz to 10 Hz (Note 3)                                                                                                                            |                                               | 0.38                                                        | 0.65                            | $\mu Vp-p$       |
| $e_n$       | Input Noise Voltage Density                              | $f_O = 10$ Hz<br>$f_O = 100$ Hz (Note 3)<br>$f_O = 1000$ Hz                                                                                         |                                               | 10.5<br>10.3<br>9.8                                         | 20.0<br>13.5<br>11.5            | $nV/\sqrt{Hz}$   |
| $i_{np-p}$  | Input Noise Current                                      | 0.1 Hz to 10 Hz (Note 3)                                                                                                                            |                                               | 15                                                          | 35                              | $pAp-p$          |
| $i_n$       | Input Noise Current Density                              | $f_O = 10$ Hz<br>$f_O = 100$ Hz (Note 3)<br>$f_O = 1000$ Hz                                                                                         |                                               | 0.35<br>0.15<br>0.13                                        | 0.90<br>0.27<br>0.18            | $pA/\sqrt{Hz}$   |
| $R_{IN}$    | Input Resistance Differential-Mode                       | (Note 4)                                                                                                                                            | 7                                             | 31                                                          |                                 | $M\Omega$        |
| $R_{INCM}$  | Input Resistance Common-Mode                             |                                                                                                                                                     |                                               | 120                                                         |                                 | $G\Omega$        |
| IVR         | Input Voltage Range                                      |                                                                                                                                                     | $\pm 13$                                      | $\pm 14$                                                    |                                 | V                |
| CMRR        | Common-Mode Rejection Ratio                              | $V_{CM} = \pm 13V$                                                                                                                                  | 94<br><b>94</b>                               | 110<br><b>106</b>                                           |                                 | dB               |
| PSRR        | Power Supply Rejection Ratio                             | $V_S = \pm 3V$ to $\pm 18V$                                                                                                                         |                                               | 7<br><b>10</b>                                              | 32<br><b>51</b>                 | $\mu V/V$        |
| $A_{VO}$    | Large Signal Voltage Gain                                | $R_L \leq 2 k\Omega$ , $V_O = \pm 10V$<br>$R_L = 2 k\Omega$ , $V_O = \pm 10V$<br>$R_L \geq 500\Omega$ , $V_O = \pm 0.5V$ ,<br>$V_S \pm 3V$ (Note 4) | 120<br><b>100</b>                             | 400<br><b>400</b><br>400                                    |                                 | V/mV             |
| $V_O$       | Output Voltage Swing                                     | $R_L \geq 10 k\Omega$<br>$R_L \geq 2 k\Omega$<br>$R_L \geq 2 k\Omega$<br>$R_L \geq 1 k\Omega$                                                       | $\pm 12.0$<br>$\pm 11.5$<br>$\pm$ <b>11.0</b> | $\pm 13.0$<br>$\pm 12.8$<br>$\pm$ <b>12.6</b><br>$\pm 12.0$ |                                 | V                |
| SR          | Slew Rate                                                | $R_L \geq 2 k\Omega$ (Note 3)                                                                                                                       | 0.1                                           | 0.3                                                         |                                 | $V/\mu s$        |
| BW          | Closed-Loop Bandwidth                                    | $A_{VCL} = +1$ (Note 3)                                                                                                                             | 0.4                                           | 0.6                                                         |                                 | MHz              |
| RO          | Output Resistance                                        | $V_O = 0$ , $I_O = 0$                                                                                                                               |                                               | 60                                                          |                                 | $\Omega$         |
| $P_d$       | Power Consumption                                        | $V_S = \pm 15V$ , No Load<br>$V_S = \pm 3V$ , No Load                                                                                               |                                               | 80<br>4                                                     | 150<br>8                        | mW               |
|             | Offset Adj. Range                                        | $R_P = 20 k\Omega$                                                                                                                                  |                                               | $\pm 4$                                                     |                                 | mV               |
| $TCV_{OS}$  | Average Input Offset Voltage Drift Without External Trim | (Note 4)                                                                                                                                            |                                               | <b>0.7</b>                                                  | <b>2.5</b>                      | $\mu V/^\circ C$ |
| $TCV_{OSn}$ | With External Trim                                       | $R_P = 20 k\Omega$ (Note 4)                                                                                                                         |                                               | <b>0.7</b>                                                  | <b>2.5</b>                      | $\mu V/^\circ C$ |
| $TCI_{OS}$  | Average Input Offset Current Drift                       | (Note 3)                                                                                                                                            |                                               | <b>12</b>                                                   | <b>50</b>                       | $pA/^\circ C$    |
| $TCI_B$     | Average Input Bias Current Drift                         | (Note 3)                                                                                                                                            |                                               | <b>18</b>                                                   | <b>50</b>                       | $pA/^\circ C$    |

**Note 1:**  $V_{OS}$  is measured approximately 0.5 second after application of power.

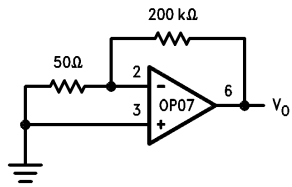
**Note 2:** Long-Term Offset Voltage Stability refers to the averaged trend line of  $V_{OS}$  vs Time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in  $V_{OS}$  during the first 30 operating days are typically  $2.5 \mu V$ . Parameter is sample tested.

**Note 3:** Sample Tested.

**Note 4:** Guaranteed by design.

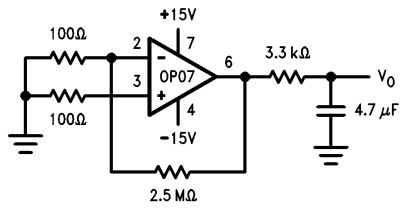
## Test Circuits

Offset Voltage Test Circuit



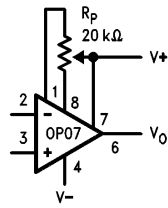
TL/H/10550-4

Low Frequency Noise Test Circuit



TL/H/10550-5

Optional Offset Nulling Circuit



TL/H/10550-6

