2MHz, Operational Transconductance Amplifier (OTA)

The CA3080 and CA3080A types are Gatable-Gain Blocks which utilize the unique operational-transconductance-amplifier (OTA) concept described in Application Note AN6668, “Applications of the CA3080 and CA3080A High-Performance Operational Transconductance Amplifiers”.

The CA3080 and CA3080A types have differential input and a single-ended, push-pull, class A output. In addition, these types have an amplifier bias input which may be used either for gating or for linear gain control. These types also have a high output impedance and their transconductance (g_m) is directly proportional to the amplifier bias current (I_{ABC}).

The CA3080 and CA3080A types are notable for their excellent slew rate (50V/μs), which makes them especially useful for multiplexer and fast unity-gain voltage followers. These types are especially applicable for multiplexer applications because power is consumed only when the devices are in the “ON” channel state.

The CA3080A’s characteristics are specifically controlled for applications such as sample-hold, gain-control, multiplexing, etc.

**Features**

- Slew Rate (Unity Gain, Compensated) ........... 50V/μs
- Adjustable Power Consumption ............... 10μW to 30μW
- Flexible Supply Voltage Range .............. ±2V to ±15V
- Fully Adjustable Gain ...................... 0 to g_mR_L Limit
- Tight g_m Spread:
  - CA3080 .......................... 2:1
  - CA3080A ....................... 1.6:1
- Extended g_m Linearity ............... 3 Decades

**Applications**

- Sample and Hold
- Multiplexer
- Voltage Follower
- Multiplier
- Comparator

**Pinouts**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>INV. INPUT</td>
<td>V-</td>
<td>NC</td>
<td>OUTPUT</td>
<td>V+</td>
<td>NC</td>
<td>AMPLIFIER BIAS INPUT</td>
</tr>
</tbody>
</table>

**Part Number Information**

<table>
<thead>
<tr>
<th>PART NUMBER (BRAND)</th>
<th>TEMP. RANGE (°C)</th>
<th>PACKAGE</th>
<th>PKG. NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA3080AE</td>
<td>-55 to 125</td>
<td>8 Ld PDIP</td>
<td>E8.3</td>
</tr>
<tr>
<td>CA3080AM (3080A)</td>
<td>-55 to 125</td>
<td>8 Ld SOIC</td>
<td>M8.15</td>
</tr>
<tr>
<td>CA3080AM96 (3080A)</td>
<td>-55 to 125</td>
<td>8 Ld SOIC Tape and Reel</td>
<td>M8.15</td>
</tr>
<tr>
<td>CA3080E</td>
<td>0 to 70</td>
<td>8 Ld PDIP</td>
<td>E8.3</td>
</tr>
<tr>
<td>CA3080M (3080)</td>
<td>0 to 70</td>
<td>8 Ld SOIC</td>
<td>M8.15</td>
</tr>
<tr>
<td>CA3080M96 (3080)</td>
<td>0 to 70</td>
<td>8 Ld SOIC Tape and Reel</td>
<td>M8.15</td>
</tr>
</tbody>
</table>
Absolute Maximum Ratings

Supply Voltage (Between V+ and V- Terminal) . . . . . . . . . . . . . 36V
Differential Input Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5V
Input Voltage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . V+ to V-
Input Signal Current (I_{ABC}) . . . . . . . . . . . . . . . . . . . . . . . . . . . 1mA
Amplifier Bias Current (I_{ABC}) . . . . . . . . . . . . . . . . . . . . . . . . . . 2mA
Output Short Circuit Duration (Note 1) . . . . . . . . . . . . . . . . . . . . . . No Limitation

Operating Conditions

Temperature Range
CA3080 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 0 o C to 70 o C
CA3080A . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . -55 o C to 125 o C

CAUTION: Stresses above those listed in “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:
1. Short circuit may be applied to ground or to either supply.
2. \( \theta_{JA} \) is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications

For Equipment Design, \( V_{SUPPLY} = \pm 15V \), Unless Otherwise Specified

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>TEMP</th>
<th>CA3080</th>
<th>CA3080A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MIN</td>
<td>TYP</td>
</tr>
<tr>
<td>Input Offset Voltage</td>
<td>( I_{ABC} = 5\mu A )</td>
<td>25</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>-</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Full</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Input Offset Voltage Change</td>
<td>( I_{ABC} = 500\mu A ) to 5\mu A</td>
<td>25</td>
<td>-</td>
<td>0.2</td>
</tr>
<tr>
<td>Input Offset Voltage Temp. Drift</td>
<td>( I_{ABC} = 100\mu A )</td>
<td>Full</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Input Offset Voltage Sensitivity</td>
<td>Positive</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>Input Offset Current</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>-</td>
<td>0.12</td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Full</td>
<td>-</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Differential Input Current</td>
<td>( I_{ABC} = 0, V_{DIFF} = 4V )</td>
<td>25</td>
<td>-</td>
<td>0.008</td>
</tr>
<tr>
<td>Amplifier Bias Voltage</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>-</td>
<td>0.71</td>
</tr>
<tr>
<td>Input Resistance</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>Input Capacitance</td>
<td>( I_{ABC} = 500\mu A, f = 1MHz )</td>
<td>25</td>
<td>-</td>
<td>3.6</td>
</tr>
<tr>
<td>Input-to-Output Capacitance</td>
<td>( I_{ABC} = 500\mu A, f = 1MHz )</td>
<td>25</td>
<td>-</td>
<td>0.024</td>
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<tr>
<td>Common-Mode Input-Voltage Range</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>12 to</td>
<td>13.6 to</td>
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<tr>
<td>Forward Transconductance (Large Signal)</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>6700</td>
<td>9600</td>
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<tr>
<td></td>
<td>Full</td>
<td>5400</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Output Capacitance</td>
<td>( I_{ABC} = 500\mu A, f = 1MHz )</td>
<td>25</td>
<td>-</td>
<td>5.6</td>
</tr>
<tr>
<td>Output Resistance</td>
<td>( I_{ABC} = 500\mu A )</td>
<td>25</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>Peak Output Current</td>
<td>( I_{ABC} = 5\mu A, R_L = 0\Omega )</td>
<td>25</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>( I_{ABC} = 500\mu A, R_L = 0\Omega )</td>
<td>25</td>
<td>350</td>
<td>500</td>
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<tr>
<td></td>
<td>Full</td>
<td>300</td>
<td>-</td>
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### Electrical Specifications

For Equipment Design, \( V_{\text{SUPPLY}} = \pm 15\text{V}, \) Unless Otherwise Specified (Continued)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>TEMP</th>
<th>CA3080</th>
<th>CA3080A</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td>MIN</td>
<td>TYP</td>
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<tr>
<td></td>
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<td></td>
<td>UNITS</td>
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<tr>
<td>Peak Output Voltage</td>
<td>Positive</td>
<td>25</td>
<td>13.8</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>25</td>
<td>-14.5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>25</td>
<td>13.5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>25</td>
<td>-14.4</td>
<td>-</td>
</tr>
<tr>
<td>Amplifier Supply Current</td>
<td>( I_{ABC} = 500\mu\text{A} )</td>
<td>25</td>
<td>0.8</td>
<td>1</td>
</tr>
<tr>
<td>Device Dissipation</td>
<td>( I_{ABC} = 500\mu\text{A} )</td>
<td>25</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>Magnitude of Leakage Current</td>
<td>( I_{ABC} = 0, V_{TP} = 0 )</td>
<td>25</td>
<td>0.08</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>( I_{ABC} = 0, V_{TP} = 36\text{V} )</td>
<td>25</td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>Propagation Delay</td>
<td>( I_{ABC} = 500\mu\text{A} )</td>
<td>25</td>
<td>45</td>
<td>-</td>
</tr>
<tr>
<td>Common-Mode Rejection Ratio</td>
<td>( I_{ABC} = 500\mu\text{A} )</td>
<td>25</td>
<td>80</td>
<td>110</td>
</tr>
<tr>
<td>Open-Loop Bandwidth</td>
<td>( I_{ABC} = 500\mu\text{A} )</td>
<td>25</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Slew Rate</td>
<td>Uncompensated</td>
<td>25</td>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Compensated</td>
<td>25</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>

### Schematic Diagram

FIGURE 1. SCHEMATIC DIAGRAM OF THE CA3080 AND CA3080A IN A UNITY-GAIN VOLTAGE FOLLOWER CONFIGURATION AND ASSOCIATED WAVEFORM

### Typical Applications

FIGURE 1. SCHEMATIC DIAGRAM OF THE CA3080 AND CA3080A IN A UNITY-GAIN VOLTAGE FOLLOWER CONFIGURATION AND ASSOCIATED WAVEFORM
Typical Applications (Continued)

**FIGURE 2.** 1,000,000/1 SINGLE-CONTROL FUNCTION GENERATOR - 1MHz TO 1Hz

**NOTE:** A Square-Wave Signal Modulates The External Sweeping Input to Produce 1Hz and 1MHz, showing the 1,000,000/1 frequency range of the function generator.

**FIGURE 3A.** TWO-TONE OUTPUT SIGNAL FROM THE FUNCTION GENERATOR

**FIGURE 3B.** TRIPLE-TRACE OF THE FUNCTION GENERATOR SWEEPING TO 1MHz

**FIGURE 3.** FUNCTION GENERATOR DYNAMIC CHARACTERISTICS WAVEFORMS

**NOTE:** The bottom trace is the sweeping signal and the top trace is the actual generator output. The center trace displays the 1MHz signal via delayed oscilloscope triggering of the upper swept output signal.
Typical Applications  (Continued)

**FIGURE 4. SCHEMATIC DIAGRAM OF THE CA3080A IN A SAMPLE-HOLD CONFIGURATION**

**FIGURE 5. SAMPLE AND HOLD CIRCUIT**

NOTE: Time required for output to settle within ±3mV of a 4V step.

SLEW RATE (IN SAMPLE MODE) = 1.3V/µs
ACQUISITION TIME = 3µs (NOTE)

CA3080, CA3080A
Typical Applications (Continued)

Top Trace: Output Signal
5V/Div., 2μs/Div.
Bottom Trace: Input Signal
5V/Div., 2μs/Div.
Center Trace: Difference of Input and Output Signals Through Tektronix Amplifier 7A13
5mV/Div., 2μs/Div.

FIGURE 6. LARGE SIGNAL RESPONSE AND SETTLING TIME FOR CIRCUIT SHOWN IN FIGURE 5

Top Trace: System Output; 100mV/Div., 500ns/Div.
Bottom Trace: Sampling Signal; 20V/Div., 500ns/Div.

FIGURE 7. SAMPLING RESPONSE FOR CIRCUIT SHOWN IN FIGURE 5

Top Trace: Output; 50mV/Div., 200ns/Div.
Bottom Trace: Input; 50mV/Div., 200ns/Div.

FIGURE 8. INPUT AND OUTPUT RESPONSE FOR CIRCUIT SHOWN IN FIGURE 5

NOTE: All resistors 1/2 watt, unless otherwise specified.

FIGURE 9. THERMOCOUPLE TEMPERATURE CONTROL WITH CA3079 ZERO VOLTAGE SWITCH AS THE OUTPUT AMPLIFIER
Typical Applications (Continued)

FIGURE 10. SCHEMATIC DIAGRAM OF THE CA3080A IN A SAMPLE-HOLD CIRCUIT WITH BIMOS OUTPUT AMPLIFIER

FIGURE 11. LARGE-SIGNAL RESPONSE FOR CIRCUIT SHOWN IN FIGURE 10

FIGURE 12. SMALL-SIGNAL RESPONSE FOR CIRCUIT SHOWN IN FIGURE 10
Typical Applications (Continued)

![Propagation Delay Test Circuit and Associated Waveforms](image)

Typical Performance Curves

![Input Offset Voltage vs Amplifier Bias Current](image)

![Input Offset Current vs Amplifier Bias Current](image)

![Input Bias Current vs Amplifier Bias Current](image)

![Peak Output Current vs Amplifier Bias Current](image)
Typical Performance Curves (Continued)

FIGURE 18. PEAK OUTPUT VOLTAGE vs AMPLIFIER BIAS CURRENT

FIGURE 19. AMPLIFIER SUPPLY CURRENT vs AMPLIFIER BIAS CURRENT

FIGURE 20. TOTAL POWER DISSIPATION vs AMPLIFIER BIAS CURRENT

FIGURE 21. TRANSconductance vs AMPLIFIER BIAS CURRENT

FIGURE 22. LEAKAGE CURRENT TEST CIRCUIT

FIGURE 23. LEAKAGE CURRENT vs TEMPERATURE
Typical Performance Curves (Continued)

**FIGURE 24. DIFFERENTIAL INPUT CURRENT TEST CIRCUIT**

**FIGURE 25. INPUT CURRENT vs INPUT DIFFERENTIAL VOLTAGE**

**FIGURE 26. INPUT RESISTANCE vs AMPLIFIER BIAS CURRENT**

**FIGURE 27. AMPLIFIER BIAS VOLTAGE vs AMPLIFIER BIAS CURRENT**

**FIGURE 28. INPUT AND OUTPUT CAPACITANCE vs AMPLIFIER BIAS CURRENT**

**FIGURE 29. OUTPUT RESISTANCE vs AMPLIFIER BIAS CURRENT**

SUPPLY VOLTS: $V_S = \pm 15\text{V}$

Temperature:
- $25^\circ\text{C}$
- $-55^\circ\text{C}$
- $125^\circ\text{C}$

Input and Output Capacitance ($\text{pF}$)

- $C_I$
- $C_O$

Input and Output Resistance ($\text{M\Omega}$)

- $1\text{M\Omega}$
- $10\text{M\Omega}$
- $100\text{M\Omega}$
- $1000\text{M\Omega}$

Input Bias Current ($\mu\text{A}$)

- $0.1\mu\text{A}$
- $1\mu\text{A}$
- $10\mu\text{A}$
- $100\mu\text{A}$
- $1\text{mA}$
- $10\text{mA}$
- $100\text{mA}$
- $1\text{A}$

Input Differential Voltage (V)

- $1\text{V}$
- $2\text{V}$
- $3\text{V}$
- $4\text{V}$
- $5\text{V}$
- $6\text{V}$
- $7\text{V}$

Input Differential Current (pA)

- $10^2\text{pA}$
- $10^3\text{pA}$
- $10^4\text{pA}$

Input and Output Capacitance ($\text{pF}$) vs Amplifier Bias Current ($\mu\text{A}$)

Input Resistance ($\text{M\Omega}$) vs Amplifier Bias Current ($\mu\text{A}$)

Bias Voltage (mV) vs Amplifier Bias Current ($\mu\text{A}$)
Typical Performance Curves (Continued)

FIGURE 30. INPUT-TO-OUTPUT CAPACITANCE TEST CIRCUIT

FIGURE 31. INPUT-TO-OUTPUT CAPACITANCE vs SUPPLY VOLTAGE

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