

Amplifiers and Comparators

In Brief . . .

For over two decades, Motorola has continually refined and updated integrated circuit technologies, analog circuit design techniques and processes in response to the needs of the marketplace. The enhanced performance of newer operational amplifiers and comparators has come through innovative application of these technologies, designs and processes. Some early designs are still available but are giving way to the new, higher performance operational amplifier and comparator circuits. Motorola has pioneered in JFET inputs, low temperature coefficient input stages, Miller loop compensation, all NPN output stages, dual-doublet frequency compensation and analog "in-the-package" trimming of resistors to produce superior high performance operational amplifiers and comparators, operating in many cases from a single supply with low input offset, low noise, low power, high output swing, high slew rate and high gain-bandwidth product at reasonable cost to the customer.

Present day operational amplifiers and comparators find applications in all market segments including motor controls, instrumentation, aerospace, automotive, telecommunications, medical, and consumer products.

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Operational Amplifiers

Motorola offers a broad line of bipolar operational amplifiers to meet a wide range of applications. From low-cost industry-standard types to high precision circuits, the span encompasses a large range of performance capabilities. These Analog integrated circuits are available as single, dual

and quad monolithic devices in a variety of temperature ranges and package styles. Most devices may be obtained in unencapsulated "chip" form as well. For price and delivery information on chips, please contact your Motorola Sales Representative or Distributor.

Table 1. Single Operational Amplifiers

| Device | I_{IB} (μ A) Max | V_{IO} (mV) Max | TC_{VIO} (μ V/ $^{\circ}$ C) Typ | I_{IO} (nA) Max | A_{vol} (V/mV) Min | BW ($A_V = 1$) (MHz) Typ | SR ($A_V = 1$) (V/ μ s) Typ | Supply Voltage (V) | | Description | Suffix/ Package |
|--|-------------------------------|-------------------------|---|-------------------------|----------------------------|-------------------------------------|--|--------------------------|-----------|--|--------------------|
| | | | | | | | | Min | Max | | |
| Noncompensated | | | | | | | | | | | |
| Commercial Temperature Range (0$^{\circ}$C to +70$^{\circ}$C) | | | | | | | | | | | |
| LM301A | 0.25 | 7.5 | 10 | 50 | 25 | 1.0 | 0.5 | \pm 3.0 | \pm 18 | General Purpose | N/626, D/751 |
| LM308A | 7.0 | 0.5 | 5.0 | 1.0 | 80 | 1.0 | 0.3 | \pm 3.0 | \pm 18 | Precision | N/626, D/751 |
| Industrial Temperature Range (-25$^{\circ}$C to +85$^{\circ}$C) | | | | | | | | | | | |
| LM201A | 0.075 | 2.0 | 10 | 10 | 50 | 1.0 | 0.5 | \pm 3.0 | \pm 22 | General Purpose | N/626, D/751 |
| Internally Compensated | | | | | | | | | | | |
| Commercial Temperature Range (0$^{\circ}$C to +70$^{\circ}$C) | | | | | | | | | | | |
| LF351 | 200 pA | 10 | 10 | 100 pA | 25 | 4.0 | 13 | \pm 5.0 | \pm 18 | JFET Input | N/626, D/751 |
| LF411C | 200 pA | 2.0 | 10 | 100 pA | 25 | 8.0 | 25 | +5.0 | \pm 22 | JFET Input, Low Offset, Low Drift | N/626, D/751 |
| MC1436, C | 0.04 | 10 | 12 | 10 | 70 | 1.0 | 2.0 | \pm 15 | \pm 34 | High Voltage | P1/626, D/751 |
| MC1741C | 0.5 | 6.0 | 15 | 200 | 20 | 1.0 | 0.5 | \pm 3.0 | \pm 18 | General Purpose | P1/626, D/751 |
| MC1776C | 0.003 | 6.0 | 15 | 3.0 | 100 | 1.0 | 0.2 | \pm 1.2 | \pm 18 | μ Power, Programmable | P1/626, D/751 |
| MC3476 | 0.05 | 6.0 | 15 | 25 | 50 | 1.0 | 0.2 | \pm 1.5 | \pm 18 | Low Cost, μ Power, Programmable | P1/626 |
| MC34001 | 200 pA | 10 | 10 | 100 pA | 25 | 4.0 | 13 | \pm 5.0 | \pm 18 | JFET Input | P/626, D/751 |
| MC34001B | 200 pA | 5.0 | 10 | 100 pA | 50 | 4.0 | 13 | \pm 5.0 | \pm 18 | JFET Input | P/626, D/751 |
| MC34071 | 0.5 | 5.0 | 10 | 75 | 25 | 4.5 | 10 | +3.0 | +44 | High Performance | P/626, D/751 |
| MC34071A | 500 nA | 3.0 | 10 | 50 | 50 | 4.5 | 10 | +3.0 | +44 | Single Supply | P/626, D/751 |
| MC34080B | 200 pA | 1.0 | 10 | 100 pA | 25 | 16 | 55 | \pm 5.0 | \pm 22 | Decompensated | P/626, D/751 |
| MC34081B | 200 pA | 1.0 | 10 | 100 pA | 25 | 8.0 | 30 | \pm 5.0 | \pm 22 | High Speed, JFET Input | P/626, D/751 |
| MC34181 | 0.1 nA | 2.0 | 10 | 0.05 | 25 | 4.0 | 10 | \pm 2.5 | \pm 18 | Low Power, JFET Input | P/626 |
| TL071AC | 200 pA | 6.0 | 10 | 50 pA | 50 | 4.0 | 13 | \pm 5.0 | \pm 18 | Low Noise, JFET Input | P/626 |
| TL071C | 200 pA | 10 | 10 | 50 pA | 25 | 4.0 | 13 | \pm 5.0 | \pm 18 | Low Noise, JFET Input | D/751 |
| TL081AC | 200 pA | 6.0 | 10 | 100 pA | 50 | 4.0 | 13 | \pm 5.0 | \pm 18 | JFET Input | P/626 |
| TL081C | 400 pA | 15 | 10 | 200 pA | 25 | 4.0 | 13 | \pm 5.0 | \pm 18 | JFET Input | D/751 |
| Automotive Temperature Range (-40$^{\circ}$C to +85$^{\circ}$C) | | | | | | | | | | | |
| MC33071 | 0.5 | 5.0 | 10 | 75 | 25 | 4.5 | 10 | +3.0 | +44 | High Performance | P/626, D/751 |
| MC33071A | 500 nA | 3.0 | 10 | 50 | 50 | 4.5 | 10 | +3.0 | +44 | Single Supply | P/626, D/751 |
| MC33171 | 0.1 | 4.5 | 10 | 20 | 50 | 1.8 | 2.1 | +3.0 | +44 | Low Power, Single Supply | P/626, D/751 |
| MC33181 | 0.1 nA | 2.0 | 10 | 0.05 | 25 | 4.0 | 10 | \pm 2.5 | \pm 18 | Low Power, JFET Input | P/626, D/751 |
| Extended Temperature Range (-40$^{\circ}$C to +105$^{\circ}$C) | | | | | | | | | | | |
| MC33201 | 250 nA | 9.0 | 2.0 | 100 | 50 | 2.2 | 1.0 | \pm 0.9 | \pm 6.0 | Low V Rail-to-Rail | P/626, D/751 |
| Military Temperature Range (-55$^{\circ}$C to +125$^{\circ}$C) | | | | | | | | | | | |
| MC33201 | 400 nA | 9.0 | 2.0 | 200 | 50 | 2.2 | 1.0 | \pm 0.9 | \pm 6.0 | Low V Rail-to-Rail | P/626, D/751 |

Table 2. Dual Operational Amplifiers

| Device | I_{IB} | V_{IO} | TC_{VIO} | I_{IO} | A_{Vol} | BW | SR | Supply Voltage | | Description | Suffix/ Package |
|--|--------------------|-------------|------------------------------|-------------|---------------|-------------------------------|---------------------------------------|-------------------|-----------------|---|------------------------------|
| | (μA) Max | (mV) Max | ($\mu V/^{\circ}C$) Typ | (nA) Max | (V/mV) Min | ($A_V = 1$) (MHz) Typ | ($A_V = 1$) (V/ μs) Typ | Min | Max | | |
| Internally Compensated | | | | | | | | | | | |
| Commercial Temperature Range (0°C to +70°C) | | | | | | | | | | | |
| LF353 | 200 pA | 10 | 10 | 100 pA | 25 | 4.0 | 13 | ± 5.0 | ± 18 | JFET Input | N/626, D/751 |
| LF412C | 200 pA | 3.0 | 10 | 100 pA | 25 | 4.0 | 13 | +5.0 | ± 18 | JFET Input, Low Offset, Low Drift | N/626, D/751 |
| LF442C | 100 pA | 5.0 | 10 | 50 pA | 25 | 2.0 | 6.0 | ± 5.0 | ± 18 | Low Power, JFET Input | N/626 |
| LM358 | 0.25 | 6.0 | 7.0 | 50 | 25 | 1.0 | 0.6 | ± 1.5 +3.0 | ± 18 +36 | Single Supply, Low Power Consumption | N/626, D/751 |
| LM833 | 1.0 | 5.0 | 2.0 | 200 | 31.6 | 15 | 7.0 | ± 2.5 | ± 18 | Low Noise, Audio | N/626, D/751 |
| MC1458 | 0.5 | 6.0 | 10 | 200 | 20 | 1.1 | 0.8 | ± 3.0 | ± 18 | Dual MC1741 | P1/626, D/751 |
| MC1458C | 0.7 | 10 | 10 | 300 | 20 | 1.1 | 0.8 | ± 3.0 | ± 18 | General Purpose | P1/626, D/751 |
| MC3458 | 0.5 | 10 | 7.0 | 50 | 20 | 1.0 | 0.6 | ± 1.5 +3.0 | ± 18 +36 | Split Supplies, Single Supply, Low Crossover Distortion | P1/626, D/751 |
| MC4558AC | 0.5 | 5.0 | 10 | 200 | 50 | 2.8 | 1.6 | ± 3.0 | ± 22 | High Frequency | P1/626 |
| MC4558C | 0.5 | 6.0 | 10 | 200 | 20 | 2.8 | 1.6 | ± 3.0 | ± 18 | High Frequency | P1/626, D/751 |
| MC34002 | 100 pA | 10 | 10 | 100 pA | 25 | 4.0 | 13 | ± 5.0 | ± 18 | JFET Input | P/626, D/751 |
| MC34002B | 100 pA | 5.0 | 10 | 70 pA | 25 | 4.0 | 13 | ± 5.0 | ± 18 | JFET Input | P/626, D/751 |
| MC34072 | 0.5 | 5.0 | 10 | 75 | 25 | 4.5 | 10 | +3.0 | +44 | High Performance | P/626, D/751 |
| MC34072A | 500 nA | 3.0 | 10 | 50 | 50 | 4.5 | 10 | +3.0 | +44 | Single Supply | P/626, D/751 |
| MC34082 | 200 pA | 3.0 | 10 | 100 pA | 25 | 8.0 | 30 | ± 5.0 | ± 22 | High Speed, JFET Input | P/626 |
| MC34083B | 200 pA | 3.0 | 10 | 100 pA | 25 | 16 | 55 | ± 5.0 | ± 22 | Decompensated | P/626 |
| MC34182 | 0.1 nA | 3.0 | 10 | 0.05 | 25 | 4.0 | 10 | ± 2.5 | ± 18 | Low Power, JFET Input | P/626, D/751 |
| TL062AC | 200 pA | 6.0 | 10 | 100 pA | 4.0 | 2.0 | 6.0 | ± 2.5 | ± 18 | Low Power, JFET Input | P/626, D/751 |
| TL062C | 200 pA | 15 | 10 | 200 pA | 4.0 | 2.0 | 6.0 | ± 2.5 | ± 18 | Low Power, JFET Input | P/626, D/751 |
| TL072AC | 200 pA | 6.0 | 10 | 50 pA | 50 | 4.0 | 13 | ± 5.0 | ± 18 | Low Noise, JFET Input | P/626 |
| TL072C | 200 pA | 10 | 10 | 50 pA | 25 | 4.0 | 13 | ± 5.0 | ± 18 | Low Noise, JFET Input | D/751 |
| TL082AC | 200 pA | 6.0 | 10 | 100 pA | 50 | 4.0 | 13 | ± 5.0 | ± 18 | JFET Input | P/626 |
| TL082C | 400 pA | 15 | 10 | 200 pA | 25 | 4.0 | 13 | ± 5.0 | ± 18 | JFET Input | D/751 |
| Industrial Temperature Range (-25°C to +85°C) | | | | | | | | | | | |
| LM258 | 0.15 | 5.0 | 10 | 30 | 50 | 1.0 | 0.6 | ± 1.5 +3.0 | ± 18 +36 | Split or Single Supply Op Amp | N/626, D/751 |
| Automotive Temperature Range (-40°C to +85°C) | | | | | | | | | | | |
| MC3358 | 5.0 | 8.0 | 10 | 75 | 20 | 1.0 | 0.6 | ± 1.5 +3.0 | ± 18 +36 | Split or Single Supply | P1/626 |
| MC33072 | 0.50 | 5.0 | 10 | 75 | 25 | 4.5 | 10 | +3.0 | +44 | High Performance | P/626, D/751 |
| MC33072A | 500 nA | 3.0 | 10 | 50 | 50 | 4.5 | 10 | +3.0 | +44 | Single Supply | P/626, D/751 |
| MC33076 | 0.5 | 4.0 | 2.0 | 70 | 25 | 7.4 | 2.6 | ± 2.0 | ± 18 | High Output Current | P1/626, P2/648C, D/751 |
| MC33077 | 1.0 | 1.0 | 2.0 | 180 | 150 | 37 | 11 | ± 2.5 | ± 18 | Low Noise | P/626, D/751 |
| MC33078 | 750 nA | 2.0 | 2.0 | 150 | 31.6 | 16 | 7.0 | ± 5.0 | ± 18 | Low Noise | N/626, D/751 |
| MC33102 (Awake) | 600 nA | 3.0 | 1.0 | 60 | 25 | 4.6 | 1.7 | ± 2.5 | ± 18 | Sleep-Mode™ | P/626, D/751 |
| MC33102 (Sleep) | 60 nA | 3.0 | 1.0 | 6.0 | 15 | 0.3 | 0.1 | ± 2.5 | ± 18 | Micropower | P/626, D/751 |
| MC33172 | 0.10 | 4.5 | 10 | 20 | 50 | 1.8 | 2.1 | +3.0 | +44 | Low Power, Single Supply | P/626, D/751 |
| MC33178 | 0.5 | 3.0 | 2.0 | 50 | 50 | 5.0 | 2.0 | ± 2.0 | ± 18 | High Output Current | P/626, D/751 |
| MC33182 | 0.1 nA | 3.0 | 10 | 0.05 | 25 | 4.0 | 10 | ± 2.5 | ± 18 | Low Power, JFET Input | P/626, D/751 |
| MC33272A | 650 nA | 1.0 | 0.56 | 25 nA | 31.6 | 5.5 | 11.5 | ± 1.5 | ± 18 | High Performance | P/626, D/751 |
| MC33282 | 100 pA | 200 μV | 5.0 | 50 pA | 50 | 30 | 12 | ± 2.5 | ± 18 | Low Input, Offset JFET | P/626, D/751 |
| TL062V | 200 pA | 6.0 | 10 | 100 pA | 4.0 | 2.0 | 6.0 | ± 2.5 | ± 18 | Low Power, JFET Input | P/626, D/751 |

Table 2. Dual Operational Amplifiers (continued)

| Device | I _B (μA) Max | V _{IO} (mV) Max | TC _{VIO} (μV/°C) Typ | I _{IO} (nA) Max | A _{vol} (V/mV) Min | BW (A _V = 1) (MHz) Typ | SR (A _V = 1) (V/μs) Typ | Supply Voltage (V) | | Description | Suffix/ Package |
|--|-------------------------------|--------------------------------|-------------------------------------|--------------------------------|-----------------------------------|--|---|-----------------------|------------|---|----------------------------------|
| | | | | | | | | Min | Max | | |
| Extended Temperature Range (–40°C to +105°C) | | | | | | | | | | | |
| MC33202 MC33206 | 250 nA | 11 | 2.0 | 100 | 50 | 2.2 | 1.0 | ±0.9 | ±6.0 | Low V Rail-to-Rail Rail-to-Rail with Enable | P/626, D/751 P/646, D/751A |
| MC33502 | 40 fA typ | 0.5 typ | 2.0 typ | – | 100 typ | 4.0 typ | 4.0 typ | +0.9 | +7.0 | 1.0 V Rail-to-Rail | P/262, D751 |
| LM2904 | 0.25 | 10 | 7.0 | 50 | 100 typ | 1.0 | 0.6 | ±1.5 +3.0 | ±13 +26 | Split or Single Supply | N/262, D/751 |
| Extended Automotive Temperature Range (–40°C to +125°C) | | | | | | | | | | | |
| TCA0372 | 500 nA | 15 | 20 | 50 | 30 | 1.1 | 1.4 | +5.0 | +36 | Power Op Amp, Single Supply | DP2/648, DW/751G |
| LM2904V | 0.25 | 13 | 7.0 | 50 | 100 typ | 1.0 | 0.6 | ±1.5 +3.0 | ±13 +26 | Split or Single Supply | N/626, D/751 |
| Military Temperature Range (–55°C to +125°C) | | | | | | | | | | | |
| MC33202 | 400 pA | 11 | 2.0 | 200 pA | 50 | 2.2 | 1.0 | ±0.9 | ±6.0 | Low V Rail-to-Rail | P/626, D/751 |

Table 3. Quad Operational Amplifiers

| Device | I _B (μA) Max | V _{IO} (mV) Max | TC _{VIO} (μV/°C) Typ | I _{IO} (nA) Max | A _{vol} (V/mV) Min | BW (A _V = 1) (MHz) Typ | SR (A _V = 1) (V/μs) Typ | Supply Voltage (V) | | Description | Suffix/ Package |
|--|-------------------------------|--------------------------------|-------------------------------------|--------------------------------|-----------------------------------|--|---|-----------------------|------------|------------------------------------|--------------------|
| | | | | | | | | Min | Max | | |
| Internally Compensated | | | | | | | | | | | |
| Commercial Temperature Range (0°C to +70°C) | | | | | | | | | | | |
| LF347 | 200 pA | 10 | 10 | 100 pA | 25 | 4.0 | 13 | ±5.0 | ±18 | JFET Input | N/646 |
| LF347B | 200 pA | 5.0 | 10 | 100 pA | 50 | 4.0 | 13 | ±5.0 | ±18 | JFET Input | N/646 |
| LF444C | 100 pA | 10 | 10 | 50 pA | 25 | 2.0 | 6.0 | ±5.0 | ±18 | Low Power, JFET Input | N/646, D/751A |
| LM324, A | 0.25 | 6.0 | 7.0 | 50 | 25 | 1.0 | 0.6 | ±1.5 +3.0 | ±16 +32 | Low Power Consumption | N/646, D/751A |
| MC3403 | 0.5 | 10 | 7.0 | 50 | 20 | 1.0 | 0.6 | ±1.5 +3.0 | ±18 +36 | No Crossover Distortion | P/646, D/751A |
| MC4741C | 0.5 | 6.0 | 15 | 200 | 20 | 1.0 | 0.5 | ±3.0 | ±18 | Quad MC1741 | P/646, D/751A |
| MC34004 | 200 pA | 10 | 10 | 100 pA | 25 | 4.0 | 13 | ±5.0 | ±18 | JFET Input | P/646 |
| MC34004B | 200 pA | 5.0 | 10 | 100 pA | 50 | 4.0 | 13 | ±5.0 | ±18 | JFET Input | P/646 |
| MC34074 | 0.5 | 5.0 | 10 | 75 | 25 | 4.5 | 10 | +3.0 | +44 | High Performance | P/646, D/751A |
| MC34074A | 500 nA | 3.0 | 10 | 50 | 50 | 4.5 | 10 | +3.0 | +44 | Single Supply | P/646, D/751A |
| MC34084 | 200 pA | 12 | 10 | 100 pA | 25 | 8.0 | 30 | ±5.0 | ±22 | High Speed, JFET Input | P/646, DW/751G |
| MC34085B | 200 pA | 12 | 10 | 100 pA | 25 | 16 | 55 | ±5.0 | ±22 | Decompensated | P/646, DW/751G |
| MC34184 | 0.1 nA | 10 | 10 | 0.05 | 25 | 4.0 | 10 | ±2.5 | ±18 | Low Power, JFET Input | P/646, D/751A |
| TL064AC | 200 pA | 6.0 | 10 | 100 pA | 4.0 | 2.0 | 6.0 | ±2.5 | ±18 | Low Power, JFET Input | N/646, D/751A |
| TL064C | 200 pA | 15 | 10 | 200 pA | 4.0 | 2.0 | 6.0 | ±2.5 | ±18 | Low Power, JFET Input | N/646, D/751A |
| TL074AC | 200 pA | 6.0 | 10 | 50 pA | 50 | 4.0 | 13 | ±5.0 | ±18 | Low Noise, JFET Input | N/646 |
| TL074C | 200 pA | 10 | 10 | 50 pA | 25 | 4.0 | 13 | ±5.0 | ±18 | Low Noise, JFET Input | N/646 |
| TL084AC | 200 pA | 6.0 | 10 | 100 pA | 50 | 4.0 | 13 | ±5.0 | ±18 | JFET Input | N/646 |
| TL084C | 400 pA | 15 | 10 | 200 pA | 25 | 4.0 | 13 | ±5.0 | ±18 | JFET Input | N/646 |
| Industrial Temperature Range (–25°C to +85°C) | | | | | | | | | | | |
| LM224, A | 0.15 | 5.0 | 7.0 | 30 | 50 | 1.0 | 0.6 | ±1.5 +3.0 | ±16 +32 | Split Supplies or Single Supply | N/646, D/751A |

Table 3. Quad Operational Amplifiers (continued)

| Device | I_{IB} (μ A) | V_{IO} (mV) | TC_{VIO} (μ V/ $^{\circ}$ C) | I_{IO} (nA) | A_{vol} (V/mV) | BW ($A_V = 1$) (MHz) | SR ($A_V = 1$) (V/ μ s) | Supply Voltage (V) | | Description | Suffix/ Package |
|--|------------------------|------------------|--|------------------|---------------------|------------------------------|-------------------------------------|--------------------------|-----------|------------------------------------|--------------------|
| | Max | Max | Typ | Max | Min | Typ | Typ | Min | Max | | |
| Automotive Temperature Range (–40$^{\circ}$C to +85$^{\circ}$C) | | | | | | | | | | | |
| MC3303 | 0.5 | 8.0 | 10 | 75 | 20 | 1.0 | 0.6 | \pm 1.5 | \pm 18 | Differential | P/646, D/751A |
| MC33074 | 0.5 | 4.5 | 10 | 75 | 25 | 4.5 | 10 | +3.0 | +36 | General Purpose | P/646, D/751A |
| MC33074A | 500 nA | 3.0 | 10 | 50 | 50 | 4.5 | 10 | +3.0 | +44 | High Performance, Single Supply | P/646, D/751A |
| MC33079 | 750 nA | 2.5 | 2.0 | 150 | 31.6 | 9.0 | 7.0 | \pm 5.0 | \pm 18 | High Performance Low Noise | N/646, D/751A |
| MC33174 | 0.1 | 4.5 | 10 | 20 | 50 | 1.8 | 2.1 | +3.0 | +44 | Low Power, Single Supply | P/646, D/751A |
| MC33179 | 0.5 | 3.0 | 2.0 | 50 | 50 | 5.0 | 2.0 | \pm 2.0 | \pm 18 | High Output Current | P/646, D/751A |
| MC33184 | 0.1 nA | 10 | 10 | 0.05 | 25 | 4.0 | 10 | \pm 2.5 | \pm 18 | Low Power, JFET Input | P/646, D/751A |
| MC33274A | 650 nA | 1.0 | 0.56 | 25 nA | 31.6 | 5.5 | 11.5 | \pm 1.5 | \pm 18 | High Performance | P/646, D/751A |
| MC33284 | 100 pA | 2.0 | 5.0 | 50 pA | 50 | 30 | 12 | \pm 2.5 | \pm 18 | Low Input, Offset JFET | P/646, D/751A |
| TL064V | 200 pA | 9.0 | 10 | 100 pA | 4.0 | 2.0 | 6.0 | \pm 2.5 | \pm 18 | Low Power, JFET Input | N/646, D/751A |
| Extended Temperature Range (–40$^{\circ}$C to +105$^{\circ}$C) | | | | | | | | | | | |
| MC33204 | 250 nA | 13 | 2.0 | 100 | 50 | 2.2 | 1.0 | \pm 0.9 | \pm 6.0 | Low V Rail-to-Rail | P/646, D/751A |
| MC33207 | | | | | 50 | 2.2 | | \pm 0.9 | \pm 6.0 | Rail-to-Rail with Enable | P/648, D/751B |
| MC33304 | | | | | 25 | 3.0 | | +1.8 | +12 | Sleepmode, Rail-to-Rail | P/646, D/751A |
| LM2902 | 0.5 | 10 | – | 50 | 15 | 1.0 | 0.6 | \pm 1.5 | \pm 13 | Differential Low Power | N/646, D/751A |
| | | | | | | | | +3.0 | +26 | | |
| Extended Automotive Temperature Range (–40$^{\circ}$C to +125$^{\circ}$C) | | | | | | | | | | | |
| LM2902V | 0.5 | 13 | – | 50 | 15 | 1.0 | 0.6 | \pm 1.5 | \pm 13 | Differential Low Power | N/646, D/751A |
| | | | | | | | | +3.0 | +26 | | |
| Military Temperature Range (–55$^{\circ}$C to +125$^{\circ}$C) | | | | | | | | | | | |
| MC33204 | 400 pA | 13 | 2.0 | 200 pA | 50 | 2.2 | 1.0 | \pm 0.9 | \pm 6.0 | Low V Rail-to-Rail | P/646, D/751A |

One Volt SMARTMOS™ Rail-to-Rail Dual Operational Amplifier

MC33502D, P

$T_A = -40^\circ$ to $+105^\circ\text{C}$, Case 751, 626

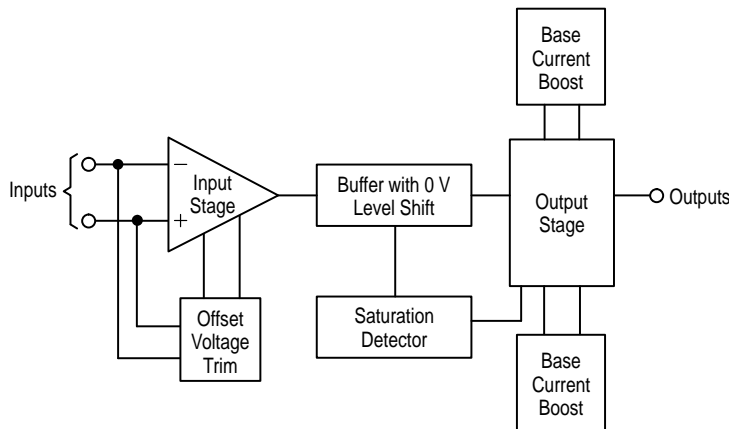
The MC33502 operational amplifier provides rail-to-rail operation on both the input and output. The output can swing within 50 mV of each rail. This rail-to-rail operation enables the user to make full use of the entire supply voltage range available. It is designed to work at very low supply voltages (1.0 V and ground), yet can operate with a supply of up to 7.0 V and ground. Output current boosting techniques provide high output current capability while keeping the drain current of the amplifier to a minimum.

- Low Voltage, Single Supply Operation (1.0 V and Ground to 7.0 V and Ground)
- High Input Impedance: Less than 40 fA Input Current
- Typical Unity Gain Bandwidth @ 5.0 V = 5.0 MHz, @ 1.0 V = 4.0 MHz
- High Output Current ($I_{SC} = 50$ mA @ 5.0 V, 10 mA @ 1.0 V)

- Output Voltage Swings within 50 mV of Both Rails
- Input Voltage Range Includes Both Supply Rails
- High Voltage Gain: 100 dB
- No Phase Reversal on the Output for Over-Driven Input Signals
- Input Offset Trimmed to <500 μV Typical
- Low Supply Current ($I_D = 1.2$ mA, Typical)
- 600 Ω Drive Capability
- Extended Operating Temperature Range (-40° to 105°C)

APPLICATIONS

- Single Cell NiCd/Ni MH Powered Systems
- Single Cell Lithium Powered Systems
- Portable Communication Devices
- Low Voltage Active Filters
- General Systems Requiring Battery Power



High Frequency Amplifiers

A variety of high frequency circuits with features ranging from low cost simplicity to multifunction versatility marks Motorola's line of integrated amplifiers. Devices described here are intended for industrial and communications applications. For devices especially dedicated to consumer products, i.e., TV and entertainment radio. (See the Consumer Electronics Circuits section.)

AGC Amplifiers

MC1490/MC1350 Family Wideband General Purpose Amplifiers

The MC1490 and MC1350 family are basic building blocks – AGC (Automatic Gain Controlled) RF/Video

Amplifiers. These parts are recommended for applications up through 70 MHz. The best high frequency performance may be obtained by using the physically smaller SOIC version (shorter leads) – MC1350D. There are currently no other RF ICs like these, because other manufacturers have dropped their copies. Applications include variable gain video and instrumentation amplifiers, IF (Intermediate Frequency) amplifiers for radio and TV receivers, and transmitter power output control. Many uses will be found in medical instrumentation, remote monitoring, video/graphics processing, and a variety of communications equipment. The family of parts using the same basic die (identical circuit with slightly different test parameters) is listed in the following table.

Table 4. High Frequency Amplifier Specifications

| Operating Temperature Range | | A _v (dB) | Bandwidth @ MHz | V _{CC} /V _{EE} (Vdc) | | Suffix/Package |
|-----------------------------|-------------|---------------------|-----------------|--|---------|----------------|
| -40° to +85°C | 0° to +70°C | Typical | | Minimum | Maximum | |
| – | MC1350 | 50 | 45 | +6.0 | +18 | P/626, D/751 |
| MC1490 | – | 50 45 35 | 10 60 100 | | | P/626 |

Miscellaneous Amplifiers

Motorola provides several Bipolar and CMOS special purpose amplifiers which fill specific needs. These devices

range from low power CMOS programmable amplifiers and comparators to variable-gain bipolar power amplifiers.

MC3405 Dual Operational Amplifier and Dual Voltage Comparator

This device contains two Differential Input Operational Amplifiers and two Comparators; each set capable of single supply operation. This operational amplifier-comparator circuit will find its applications as a general purpose product for automotive circuits and as an industrial "building block."

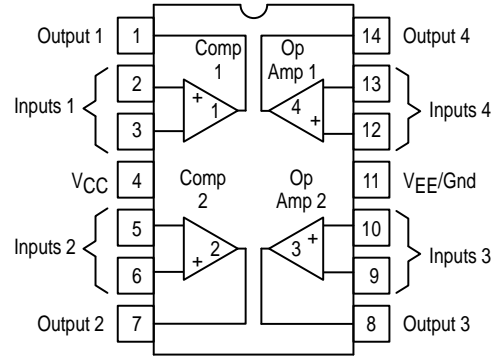


Table 5. Bipolar

| Device | I_{IB} (μA) Max | V_{IO} (mV) Max | I_{IO} (nA) Max | A_{vO1} (V/mV) Min | Response (μs) Typ | Supply Voltage | | Suffix/ Package |
|--------|--------------------------------|-------------------------|-------------------------|----------------------------|--------------------------------|----------------|-----------------------|--------------------|
| | | | | | | Single | Dual | |
| MC3405 | 0.5 | 10 | 50 | 20 | 1.3 | 3.0 to 36 | ± 1.5 to ± 18 | P/646 |

MC14573 Quad Programmable Operational Amplifier

MC14575 Dual Programmable Operational Amplifier and Dual Programmable Comparator

MC14576C/MC14577C Dual Video Amplifiers

Table 6. CMOS

| Function | Quantity Per Package | Single Supply Voltage Range | Dual Supply Voltage Range | Frequency Range | Device | Suffix/ Package |
|---|-------------------------|--------------------------------|---|-----------------|----------------------|--------------------|
| Operational Amplifiers | 4 | 3.0 to 15 V | ± 1.5 to ± 7.5 V | DC to 1.0 MHz | MC14573 | P/648, D/751B |
| Operational Amplifiers and Comparators | 2 and 2 | 3.0 to 15 V | ± 1.5 to ± 7.5 V | DC to 1.0 MHz | MC14575 | P/648, D/751B |
| Video Amplifiers | 2 | 5.0 to 12 V ⁽¹⁾ | ± 2.5 to ± 6.0 V ⁽²⁾ | Up to 10 MHz | MC14576C MC14577C | P/626, F/904 |

⁽¹⁾ 5.0 to 10 V for surface mount package.

⁽²⁾ ± 2.5 to ± 5.0 V for surface mount package.

Comparators

Table 7. Single Comparators

| Device | I _B (μ A) Max | V _{IO} (mV) Max | I _O (μ A) Max | A _V (V/V) Typ | I _O (mA) Min | Response Time (ns) | Supply Voltage (V) | Description | Temperature Range (°C) | Suffix/ Package |
|----------------|-------------------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------|--------------------------|--------------------------|---|------------------------------|--------------------------|
| Bipolar | | | | | | | | | | |
| LM211 LM311 | 0.1 0.25 | 3.0 7.5 | 0.01 0.05 | 200 k | 8.0 | 200 | +15, -15 | With strobe, will operate from single supply | -25 to +85 0 to +70 | D/751 N/626, D/751 |
| CMOS | | | | | | | | | | |
| MC14578 | 1.0 pA | 50 | - | - | 1.1 | - | 3.5 to 14 | Requires only 10 μ A from single-ended supply | -30 to +70 | P/648, D/751B |

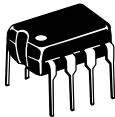
Table 8. Dual Comparators

| Device | I _B (μ A) Max | V _{IO} (mV) Max | I _O (μ A) Max | A _V (V/V) Typ | I _O (mA) Min | Response Time (ns) | Supply Voltage (V) | Description | Temperature Range (°C) | Suffix/ Package |
|--------------------------------------|-------------------------------------|--------------------------------|-------------------------------------|--------------------------------|-------------------------------|------------------------------|---|--|--|--------------------|
| Bipolar | | | | | | | | | | |
| LM393 LM393A LM2903 LM2903V | 0.25 | 5.0 2.0 7.0 7.0 | 0.05 | 200 k | 6.0 | 1300 1300 1500 1500 | \pm 1.5 to \pm 18 or 3.0 to 36 | Designed for single or split supply operation, input common mode includes ground (negative supply) | 0 to +70 0 to +70 -40 to +105 -40 to +125 | N/626, D/751 |
| MC3405 | 0.5 | 10 | 0.05 | 200 k | 6.0 | 1300 | \pm 1.5 to \pm 7.5 or 3.0 to 15 | This device contains 2 op amps and 2 comparators in a single package | 0 to +70 | P/646 |
| CMOS | | | | | | | | | | |
| MC14575 | 0.001 | 30 | 0.0001 | 2.0 k | 3.0 | 1000 | \pm 1.5 to \pm 7.5 or 3.0 to 15 | This device contains 2 op amps and 2 comparators in a single package | -40 to +85 | P/648, D/751B |

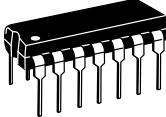
Table 9. Quad Comparators

| Device | I _B (μ A) Max | V _{IO} (mV) Max | I _O (μ A) Max | A _V (V/V) Typ | I _O (mA) Min | Response Time (ns) | Supply Voltage (V) | Description | Temperature Range (°C) | Suffix/ Package |
|---|-------------------------------------|--|-------------------------------------|---|-------------------------------|--------------------------|---|--|---|---|
| Bipolar | | | | | | | | | | |
| LM239 LM239A LM339 LM339A LM2901 LM2901V MC3302 | 0.25 0.5 | 5.0 2.0 5.0 2.0 7.0 7.0 20 | 0.05 | 200 k 200 k 200 k 200 k 100 k 100 k 100 k | 6.0 | 1300 | \pm 1.5 to \pm 18 or 3.0 to 36 | Designed for single or split supply operation, input common mode includes ground (negative supply) | -25 to +85 -25 to +85 0 to +70 0 to +70 -40 to +85 -40 to +125 -40 to +85 | N/646, D/751A P/646 |
| CMOS | | | | | | | | | | |
| MC14574 | 0.001 | 30 | 0.0001 | 2.0 k | 3.0 | 1000 | \pm 1.5 to \pm 7.5 or 3.0 to 15 | Externally programmable power dissipation with 1 or 2 resistors | -40 to +85 | P/648, D/751B |

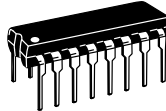
Amplifiers and Comparators Package Overview



CASE 626
N, P, P1 SUFFIX



CASE 646
N, P SUFFIX



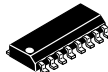
CASE 648, 648C
DP2, P, P2 SUFFIX



CASE 751
D SUFFIX



CASE 751A
D SUFFIX



CASE 751B
D SUFFIX



CASE 751G
DW SUFFIX



CASE 904
F SUFFIX