

# Amplifiers and Comparators

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## 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 <sub>B</sub> (μA) Max	V <sub>IO</sub> (mV) Max	TC <sub>VIO</sub> (μV/°C) Typ	I <sub>IO</sub> (nA) Max	A <sub>vol</sub> (V/mV) Min	BW (A <sub>V</sub> = 1) (MHz) Typ	SR (A <sub>V</sub> = 1) (V/μs) Typ	Supply Voltage (V)		Description	Suffix/ Package
	Min	Max									
Noncompensated											
Commercial Temperature Range (0°C to +70°C)											
LM301A	0.25	7.5	10	50	25	1.0	0.5	±3.0	±18	General Purpose	N/626, D/751
LM308A	7.0	0.5	5.0	1.0	80	1.0	0.3	±3.0	±18	Precision	N/626, D/751
Industrial Temperature Range (–25°C to +85°C)											
LM201A	0.075	2.0	10	10	50	1.0	0.5	±3.0	±22	General Purpose	N/626, D/751
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF351	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	N/626, D/751
LF411C	200 pA	2.0	10	100 pA	25	8.0	25	+5.0	±22	JFET Input, Low Offset, Low Drift	N/626, D/751
MC1436, C	0.04	10	12	10	70	1.0	2.0	±15	±34	High Voltage	P1/626, D/751
MC1741C	0.5	6.0	15	200	20	1.0	0.5	±3.0	±18	General Purpose	P1/626, D/751
MC1776C	0.003	6.0	15	3.0	100	1.0	0.2	±1.2	±18	μPower, Programmable	P1/626, D/751
MC3476	0.05	6.0	15	25	50	1.0	0.2	±1.5	±18	Low Cost, μPower, Programmable	P1/626
MC34001	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	P/626, D/751
MC34001B	200 pA	5.0	10	100 pA	50	4.0	13	±5.0	±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	±5.0	±22	Decompensated	P/626, D/751
MC34081B	200 pA	1.0	10	100 pA	25	8.0	30	±5.0	±22	High Speed, JFET Input	P/626, D/751
MC34181	0.1 nA	2.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	P/626
TL071AC	200 pA	6.0	10	50 pA	50	4.0	13	±5.0	±18	Low Noise, JFET Input	P/626
TL071C	200 pA	10	10	50 pA	25	4.0	13	±5.0	±18	Low Noise, JFET Input	D/751
TL081AC	200 pA	6.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	P/626
TL081C	400 pA	15	10	200 pA	25	4.0	13	±5.0	±18	JFET Input	D/751
Automotive Temperature Range (–40°C to +85°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	±2.5	±18	Low Power, JFET Input	P/626, D/751
Extended Temperature Range (–40°C to +105°C)											
MC33201	250 nA	9.0	2.0	100	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/626, D/751
Military Temperature Range (–55°C to +125°C)											
MC33201	400 nA	9.0	2.0	200	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/626, D/751

**Table 2. Dual Operational Amplifiers**

Device	I <sub>B</sub> (μA) Max	V <sub>IO</sub> (mV) Max	TC <sub>VIO</sub> (μV/°C) Typ	I <sub>O</sub> (nA) Max	A <sub>vol</sub> (V/mV) Min	BW (A <sub>V</sub> = 1) (MHz) Typ	SR (A <sub>V</sub> = 1) (V/μs) Typ	Supply Voltage (V)		Description	Suffix/ Package
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 <sub>B</sub> (μA)	V <sub>IO</sub> (mV)	TC <sub>VIO</sub> (μV/°C)	I <sub>IO</sub> (nA)	A <sub>vol</sub> (V/mV)	BW (A <sub>V</sub> = 1) (MHz)	SR (A <sub>V</sub> = 1) (V/μs)	Supply Voltage (V)		Description	Suffix/ Package
	Max	Max	Typ	Max	Min	Typ	Typ	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 <sub>B</sub> (μA) Max	V <sub>IO</sub> (mV) Max	TC <sub>VIO</sub> (μV/°C) Typ	I <sub>O</sub> (nA) Max	A <sub>vol</sub> (V/mV) Min	BW (A <sub>V</sub> = 1) (MHz) Typ	SR (A <sub>V</sub> = 1) (V/μs) Typ	Supply Voltage (V) Min    Max		Description	Suffix/ Package
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	±16	Low Power	N/646, D/751A
								+3.0	+32	Consumption	
MC3403	0.5	10	7.0	50	20	1.0	0.6	±1.5	±18	No Crossover	P/646, D/751A
								+3.0	+36	Distortion	
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	±16	Split Supplies or	N/646, D/751A
								+3.0	+32	Single Supply	

**Table 3. Quad Operational Amplifiers (continued)**

Device	I <sub>B</sub> (μA) Max	V <sub>IO</sub> (mV) Max	TC <sub>VIO</sub> (μV/°C) Typ	I <sub>O</sub> (nA) Max	A <sub>vol</sub> (V/mV) Min	BW (A <sub>V</sub> = 1) (MHz) Typ	SR (A <sub>V</sub> = 1) (V/μs) Typ	Supply Voltage (V) Min Max		Description	Suffix/ Package
Automotive Temperature Range (–40°C to +85°C)											
MC3303	0.5	8.0	10	75	20	1.0	0.6	±1.5	±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
								+3.0	+44	High Performance, Single Supply	
MC33074A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	High Performance	P/646, D/751A
MC33079	750 nA	2.5	2.0	150	31.6	9.0	7.0	±5.0	±18	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	±2.0	±18	High Output Current	P/646, D/751A
MC33184	0.1 nA	10	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	P/646, D/751A
MC33274A	650 nA	1.0	0.56	25 nA	31.6	5.5	11.5	±1.5	±18	High Performance	P/646, D/751A
MC33284	100 pA	2.0	5.0	50 pA	50	30	12	±2.5	±18	Low Input, Offset JFET	P/646, D/751A
TL064V	200 pA	9.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	N/646, D/751A
Extended Temperature Range (–40°C to +105°C)											
MC33204	250 nA	13	2.0	100	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	P/646, D/751A
MC33207					50	2.2		±0.9	±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					15	1.0		0.6	±1.5	±13	Differential Low Power
	0.5	10	–	50				+3.0	+26		
Extended Automotive Temperature Range (–40°C to +125°C)											
LM2902V	0.5	13	–	50	15	1.0	0.6	±1.5	±13	Differential Low Power	N/646, D/751A
								+3.0	+26		
Military Temperature Range (–55°C to +125°C)											
MC33204	400 pA	13	2.0	200 pA	50	2.2	1.0	±0.9	±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

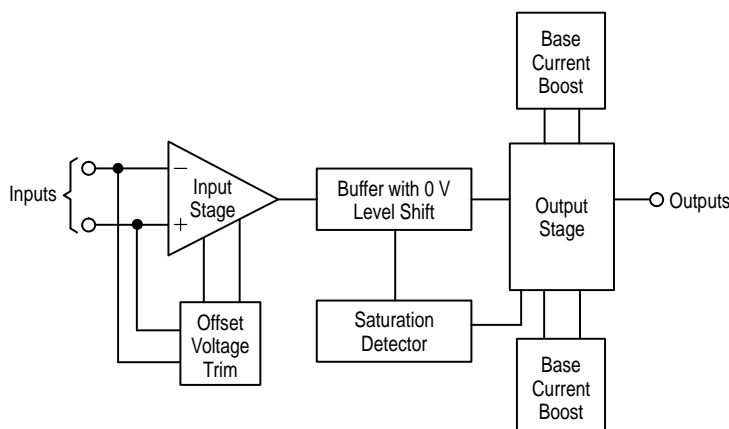
The MC33502 operational amplifier provides rail-to-rail operation on both the input and output. The output can swing within 50 mV of each rail. This rail-to-rail operation enables the user to make full use of the entire supply voltage range available. It is designed to work at very low supply voltages (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 ( $I_{SC} = 50\text{ mA}$  @ 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  $<500\text{ }\mu\text{V}$  Typical
- Low Supply Current ( $I_D = 1.2\text{ mA}$ , Typical)
- 600  $\Omega$  Drive Capability
- Extended Operating Temperature Range ( $-40^\circ$  to  $105^\circ\text{C}$ )

## 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 <sub>V</sub> (dB)	Bandwidth @ MHz	V <sub>CC</sub> /V <sub>EE</sub> (V <sub>dc</sub> )		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	10			P/626
		45	60			
		35	100			

# 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.”

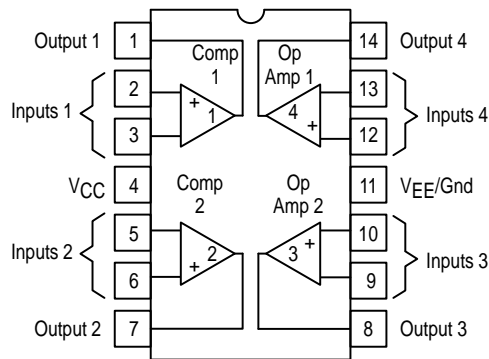


Table 5. Bipolar

Device	I <sub>B</sub> ( $\mu$ A) Max	V <sub>IO</sub> (mV) Max	I <sub>O</sub> (nA) Max	A <sub>VOI</sub> (V/mV) Min	Response ( $\mu$ s) Typ	Supply Voltage		Suffix/ Package
						Single	Dual	
MC3405	0.5	10	50	20	1.3	3.0 to 36	$\pm 1.5$ to $\pm 18$	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	$\pm 1.5$ to $\pm 7.5$ V	DC to 1.0 MHz	MC14573	P/648, D/751B
Operational Amplifiers and Comparators	2 and 2	3.0 to 15 V	$\pm 1.5$ to $\pm 7.5$ V	DC to 1.0 MHz	MC14575	P/648, D/751B
Video Amplifiers	2	5.0 to 12 V <sup>(1)</sup>	$\pm 2.5$ to $\pm 6.0$ V <sup>(2)</sup>	Up to 10 MHz	MC14576C MC14577C	P/626, F/904

(1) 5.0 to 10 V for surface mount package.  
(2)  $\pm 2.5$  to  $\pm 5.0$  V for surface mount package.

# Comparators

**Table 7. Single Comparators**

Device	I <sub>IB</sub> ( $\mu$ A) Max	V <sub>IO</sub> (mV) Max	I <sub>IO</sub> ( $\mu$ A) Max	A <sub>V</sub> (V/V) Typ	I <sub>IO</sub> (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
<b>Bipolar</b>										
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
<b>CMOS</b>										
MC14578	1.0 pA	50	—	—	1.1	—	3.5 to 14	Requires only 10 $\mu$ A from single-ended supply	-30 to +70	P/648, D/751B

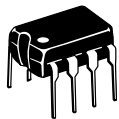
**Table 8. Dual Comparators**

Device	I <sub>IB</sub> ( $\mu$ A) Max	V <sub>IO</sub> (mV) Max	I <sub>IO</sub> ( $\mu$ A) Max	A <sub>V</sub> (V/V) Typ	I <sub>IO</sub> (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
<b>Bipolar</b>										
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
<b>CMOS</b>										
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

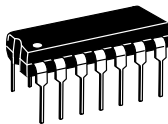
**Table 9. Quad Comparators**

Device	I <sub>IB</sub> ( $\mu$ A) Max	V <sub>IO</sub> (mV) Max	I <sub>IO</sub> ( $\mu$ A) Max	A <sub>V</sub> (V/V) Typ	I <sub>IO</sub> (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
<b>Bipolar</b>										
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
<b>CMOS</b>										
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

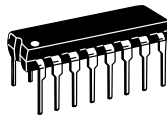
# Amplifiers and Comparators Package Overview



CASE 626  
N, P, P1 SUFFIX



CASE 646  
N, P SUFFIX



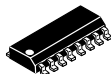
CASE 648, 648C  
DP2, P, P2 SUFFIX



CASE 751  
D SUFFIX



CASE 751A  
D SUFFIX



CASE 751B  
D SUFFIX



CASE 751G  
DW SUFFIX



CASE 904  
F SUFFIX