QUAD LOW POWER OPERATIONAL AMPLIFIERS — MC3303/3403/3503

DESCRIPTION

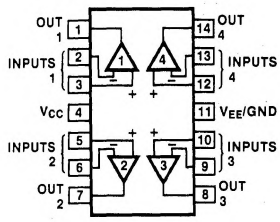
The MC3403 is a quad operational amplifier with true differential inputs. The device has electrical characteristics similar to the popular μA741. However, the MC3403 has several distinct advantages over standard operational amplifier types in single supply applications. The MC3403 can operate at supply voltages as low as 3.0V or as high as 32V. The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

FEATURES

- **Short circuit protected outputs**
- **Class AB output stage for minimal crossover distortion**
- **True differential input stage**
- **Single supply operation: 3.0 to 32V**
- **Split supply operation: ± 1.5 to ± 16V**
- **Low input bias currents: 500nA max**
- **Four amplifiers per package**
- **Internally compensated**

PIN CONFIGURATION

D, F, N PACKAGES



TOP VIEW

ORDER NUMBERS

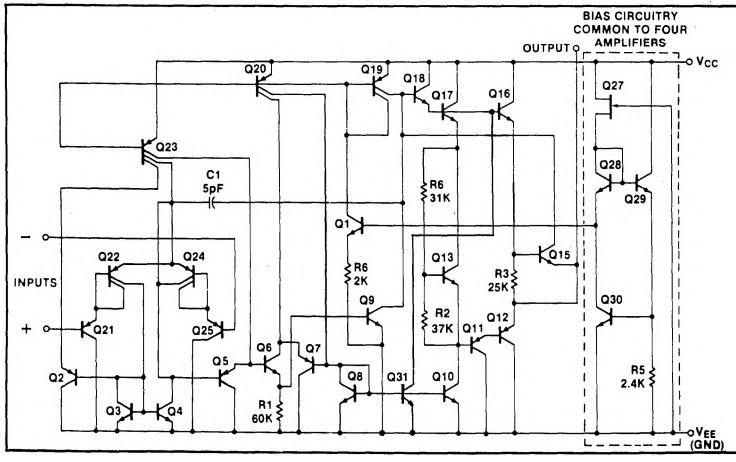
MC3303F	MC3403D	MC3503F
MC3303N	MC3403F	
	MC3403N	

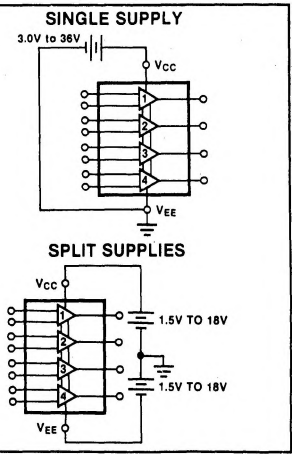
ABSOLUTE MAXIMUM RATINGS

SYMBOL AND PARAMETER		RATING	UNIT
	Power supply voltages (3)		
V_{CC}	Single supply	36	Vdc
V_{CC}	Split supplies	+ 18	Vdc
V_{EE}		− 18	Vdc
V_{IDR}	Input differential voltage range[1]	± 36	Vdc
V_{ICR}	Input common mode voltage range[1,2]	± 18	Vdc
T_{stg}	Storage temperature range		
	Ceramic package	− 65 to + 150	°C
	Plastic package	− 55 to + 125	°C
T_A	Operating ambient temperature range		
	MC3503	− 55 to + 125	°C
	MC3403	0 to + 70	°C
	MC3303	− 40 to + 85	°C
T_J	Junction temperature		
	Ceramic package	175	°C
	Plastic package	150	°C

NOTES
1. Split power supplies.
2. For supply voltages less than ± 15V, the absolute maximum input voltage is equal to the supply voltage.
3. Device not functional for single supply >32V or split supply > ± 16V

CIRCUIT SCHEMATIC (1/4 Shown)





ELECTRICAL CHARACTERISTICS (V_{CC} = +15V, V_{EE} = −15V for MC3503, MC3403; V_{CC} = +14V, V_{EE} = GND for MC3303. T_A = 25°C unless otherwise noted)

SYMBOL	AND PARAMETER	TEST CONDITIONS	MC3503			MC3403			MC3303			UNIT
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{IO}	Input offset voltage		—	2.0	5.0	—	2.0	10	—	2.0	8.0	mV
		$T_A = T_{HIGH}$ to T_{LOW}	—	—	6.0	—	—	12	—	—	10	
I_{IO}	Input offset current		—	10	50	—	10	50	—	30	75	nA
		$T_A = T_{HIGH}$ to T_{LOW}	—	—	200—	—	200—	—	250			
A_{VOL}	Large signal open-loop voltage gain	V_o = ± 10V, R_L = 2.0kΩ	50	200	—	20	200	—	20	200	—	V/mV
		$T_A = T_{HIGH}$ to T_{LOW}	25	300	—	15	—	—	15	—	—	
I_{IB}	Input bias current		—	− 30	− 500	—	− 30	− 500	—	− 30	− 500	nA
		$T_A = T_{HIGH}$ to T_{LOW}	—	− 40	− 1200	—	—	− 800	—	—	− 1000	
z_o	Output impedance	f = 20Hz	—	75	—	—	75	—	—	75	—	Ω
z_i	Input impedance	f = 20Hz	0.3	1.0	—	0.3	1.0	—	0.3	1.0	—	MΩ
V_{OR}	Output voltage range	R_L = 10kΩ	± 12	± 13.5	—	± 12	± 13.5	—	+ 12	+ 12.5	—	V
		R_L = 2.0kΩ	± 10	± 13	—	± 10	± 13	—	+ 10	+ 12	—	
		R_L = 2.0kΩ, $T_A = T_{HIGH}$ to T_{LOW}	± 10	—	—	± 10	—	—	+ 10	—	—	
V_{ICR}	Input common mode voltage range		+ 13V − V_{EE}	+ 13.5V − V_{EE}	—	+ 13V − V_{EE}	+ 13.5V − V_{EE}	—	+ 12V − V_{EE}	+ 12.5V − V_{EE}	—	V
CMRR	Common mode rejection ratio	$R_S \leq$ 10kΩ	70	90	—	70	90	—	70	90	—	dB
I_{CC}, I_{EE}	Power supply current (V_o = 0)	$R_L = \infty$	—	2.5	4.0	—	2.5	7.0	—	2.5	7.0	mA
$\Delta I_B/\Delta T$		$T_A = T_{HIGH}$ to T_{LOW}		3.5	5		3.5	7		3.5	7	mA
$I_{OS\pm}$	Individual output short circuit current[2]		± 10	± 30	± 45	± 10	± 20	± 45	± 10	± 30	± 45	mA
PSRR+	Positive power supply rejection ratio		—	30	150	—	30	150	—	30	150	μV/V
PSRR−	Negative power supply rejection ratio		—	30	150	—	30	150	—	—	—	μV/V
$\Delta I_B/\Delta T$		$T_A = T_{HIGH}$ to T_{LOW}		50			50			50		pA/°C
$\Delta I_{IO}/\Delta T$	Average temperature coeficient of input offset current	$T_A = T_{HIGH}$ to T_{LOW}	—	50	—	—	50	—	—	50	—	pA/°C
$\Delta V_{IO}/\Delta T$	Average temperature coefficient of input offset voltage	$T_A = T_{HIGH}$ to T_{LOW}	—	10	—	—	10	—	—	10	—	μV/°C
BW_P	Power bandwidth	A_v = 1, R_L = 2.0kΩ, V_o = 20V(p-p) THD = 5%	—	9.0	—	—	9.0	—	—	9.0	—	kHz
BW	Small signal bandwidth	A_v = 1, R_L = 10kΩ, V_o = 50mV	—	1.0	—	—	1.0	—	—	1.0	—	MHz
SR	Slew rate	A_v = 1, V_i = −10V to +10V	—	0.6	—	—	0.6	—	—	0.6	—	V/μs
t_{TLH}	Rise time	A_v = 1, R_L = 10kΩ, V_o = 50mV	—	0.35	—	—	0.35	—	—	0.35	—	μs
t_{THL}	Fall time	A_v = 1, R_L = 10kΩ, V_o = 50mV	—	0.35	—	—	0.35	—	—	0.35	—	μs
OS	Overshoot	A_v = 1, R_L = 10kΩ, V_o = 50mV	—	20	—	—	20	—	—	20	—	%
ϕm	Phase margin	A_v = 1, R_L = 2.0kΩ, C_L = 200pF	—	50	—	—	50	—	—	50	—	°
—	Crossover distortion	V_{IN} = 30mV(p-p), V_{OUT} = 2.0V(p-p), f = 10kHz	—	1.0	—	—	1.0	—	—	1.0	—	%

NOTES:
1. T_{HIGH} = 125°C for MC3503, 70°C for MC3303. T_{LOW} = −55°C for MC3503, 0°C for MC3403, −40°C for MC3303.
2. Not to exceed maximum package power dissipation.

QUAD LOW POWER OPERATIONAL AMPLIFIERS MC3303/3403/3503

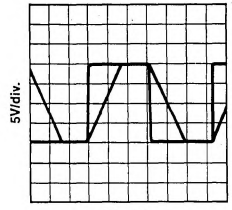
ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0V, V_E = GND, T_A = 25°C unless otherwise noted.)

SYMBOL	AND PARAMETER	TEST CONDITIONS	MC3503			MC3403			MC3303			UNIT
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{IO}	Input offset voltage		—	2.0	5.0	—	2.0	10	—	—	10	mV
I_{IO}	Input offset current		—	30	50	—	30	50	—	—	75	nA
I_{IB}	Input bias current		—	– 200	– 500	—	– 200	– 500	—	—	– 500	nA
A_{VOL}	Large signal open-loop voltage gain	R_L = 2.0kΩ	10	200	—	10	200	—	10	200	—	V/mV
PSRR	Power supply rejection ratio		—	—	150	—	—	150	—	—	150	μV/V
V_{OR}	Output voltage range[3]	R_L = 10kΩ, V_{CC} = 5.0V	3.3	3.5	—	3.3	3.5	—	3.3	3.5	—	Vp-p
		R_L = 10kΩ, 5.0V ≤ V_{CC} ≤ 30V	V_{CC} – 1.7	V_{CC} – 1.5	—	V_{CC} – 1.7	V_{CC} – 1.5	—	V_{CC} – 1.7	V_{CC} – 1.5	—	
I_{CC}	Power supply current		—	2.5	4.0	—	2.5	7.0	—	2.5	7.0	mA
—	Channel separation	f = 1.0kHz to 20kHz (Input referenced)	—	– 120	—	—	– 120	—	—	– 120	—	dB

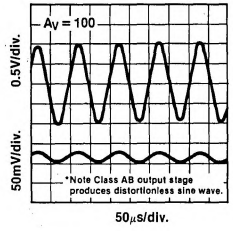
NOTE
3. Output will swing to ground.

TYPICAL PERFORMANCE CURVES

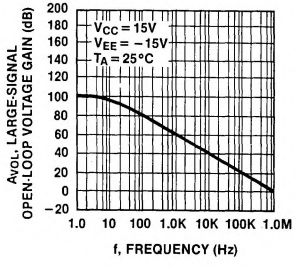
INVERTER PULSE RESPONSE



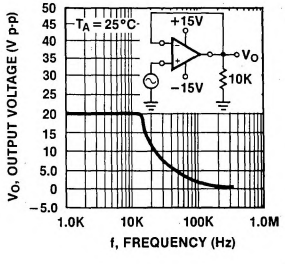
SINE WAVE RESPONSE



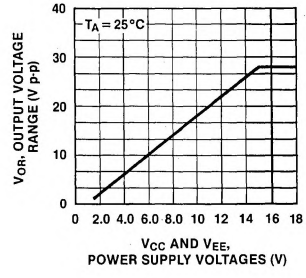
OPEN LOOP FREQUENCY RESPONSE



POWER BANDWIDTH

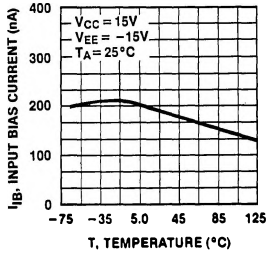


OUTPUT SWING vs SUPPLY VOLTAGE

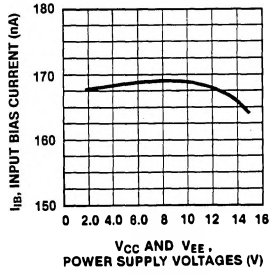


TYPICAL PERFORMANCE CURVES (Continued)

INPUT BIAS CURRENT vs TEMPERATURE



INPUT BIAS CURRENT vs SUPPLY VOLTAGE



*For additional information, consult the Applications Section.