

November 1996

Quad, 14MHz, Microprocessor BiMOS-E Operational Amplifier with MOSFET Input/Bipolar Output

Features

- High Speed CMOS Input Stage Provides
 - Very High Z_i $5T\Omega$ ($5 \times 10^{12}\Omega$) (Typ)
 - Very Low I_i 0.5pA (Typ) at 5V Operation
 - Very Low I_{IO} 0.5pA (Typ) at 5V Operation
- ESD Protection to 2000V
- 3V to 16V Power Supply Operation
- Fully Guaranteed Specifications Over Full Military Range
- Wide BW (14MHz); High SR (5V/ μ s) at 5V Supply
- Wide V_{ICR} Range From -0.5V to 3.7V (Typ) at 5V Supply
- Ideally Suited for CMOS and HCMOS Applications

Applications

- Bar Code Readers
- Photodiode Amplifiers (IR)
- Microprocessor Buffering
- Ground Reference Single Supply Amplifiers
- Fast Sample and Hold
- Timers
- Voltage Controlled Oscillators
- Voltage Followers
- V to I Converters
- Peak Detectors
- Precision Rectifiers
- 5V Logic Systems
- 3V Logic Systems

Description

The CA5470 is an operational amplifier that combines the advantages of both high speed CMOS and bipolar transistors on a single monolithic chip. It is constructed in the BiMOS-E process which adds drain-extension implants to 3 μ m polygate CMOS, enhancing both the voltage capability and providing vertical bipolar transistors for broadband analog/digital functions. This process lends itself easily to high speed operational amplifiers, comparators, analog switches and interface peripherals, resulting in twice the speed of the conventional CMOS transistors having similar feature size.

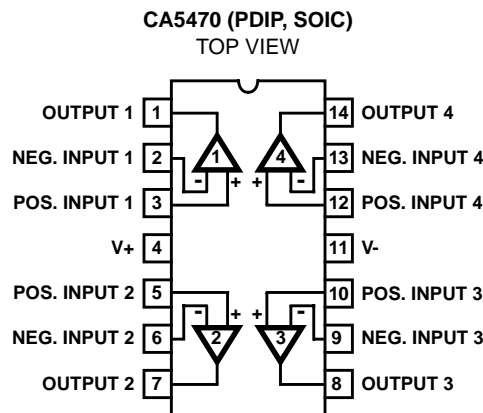
BiMOS-E are broadbased bipolar transistors that have high transconductance, gains more constant with current level, stable "precision" base-emitter offset voltages and superior drive capability. Excellent interface with environmental potentials enable use in 5V logic systems and future 3.3V logic systems. Refer to Application Note AN8811.

ESD capability exceeds the standard 2000V level. The CA5470 series can operate with single supply voltages from 3V to 16V or $\pm 1.5V$ to $\pm 8V$. They have guaranteed specifications at both 5V and $\pm 7.5V$ at room temperature as well as over the full -55 $^{\circ}C$ to 125 $^{\circ}C$ military range.

Ordering Information

PART NUMBER (BRAND)	TEMP. RANGE ($^{\circ}C$)	PACKAGE	PKG. NO.
CA5470E	-55 to 125	14 Ld PDIP	E14.3
CA5470M (5470)	-55 to 125	14 Ld SOIC	M14.15
CA5470M96 (5470)	-55 to 125	14 Ld SOIC Tape and Reel	M14.15

Pinout



CA5470

Absolute Maximum Ratings

DC Supply Voltage (Between V+ And V- Terminals) 16V
 Differential Input Voltage..... 8V
 Input Voltage..... (V+ +8V) to (V- -0.5V)
 Input Current..... 1mA
 Output Short Circuit Duration (Note 1)..... Indefinite

Thermal Information

Thermal Resistance (Typical, Note 1) θ_{JA} ($^{\circ}C/W$)
 PDIP Package 80
 SOIC Package..... 175
 Maximum Junction Temperature (Die)..... 175 $^{\circ}C$
 Maximum Junction Temperature (Plastic Package) 150 $^{\circ}C$
 Maximum Storage Temperature Range -65 $^{\circ}C$ to 150 $^{\circ}C$
 Maximum Lead Temperature (Soldering 10s) 300 $^{\circ}C$
 (SOIC - Lead Tips Only)

Operating Conditions

Temperature Range -55 $^{\circ}C$ to 125 $^{\circ}C$

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:

- Short circuit may be applied to ground or to either supply.
- θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications Typical Values Intended Only for Design Guidance at V+ = 5V, V- = 0V, T_A = 25 $^{\circ}C$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	TYPICAL VALUES	UNITS
Input Resistance	R _I		5	T Ω
Input Capacitance	C _I	f = 1MHz	3.1	pF
Unity Gain Crossover Frequency	f _T		14	MHz
Slew Rate	SR	V _{OUT} = 3.65V _{P-P}	5	V/ μ s
Transient Response:		C _L = 25pF, R _L = 2k Ω (Voltage Follower)		
Rise Time/Fall Time	t _r		27/25	ns
Overshoot	OS		20	%
Settling Time (To <0.1%, V _{IN} = 4V _{P-P})	t _S	C _L = 25pF, R _L = 2k Ω (Voltage Follower)	1	μ s
Full Power BW, SR = 5V/ μ s	FPBW	A _V = 1, V _{OUT} = 3.65V _{P-P}	436	kHz

Electrical Specifications T_A = 25 $^{\circ}C$, V+ = 5V, V- = GND

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	V _{IO}		-	6	22	mV
Input Offset Current	I _{IO}		-	0.5	50 (Note 3)	pA
Input Current	I _I		-	0.5	50 (Note 3)	pA
Common Mode Input Range	V _{ICR}		3.5	-0.5 to 3.7	0	V
Common Mode Rejection Ratio	CMRR	V _{ICR} = 0V to 3.5V	55	70	-	dB
Power Supply Rejection Ratio	PSRR	ΔV = 2V	60	75	-	dB
Positive Output Voltage Swing	V _{OM+}	R _L = 2k Ω to GND	4	4.4	-	V
Negative Output Voltage Swing	V _{OM-}	R _L = 2k Ω to GND	-	0.06	0.10	V
Total Supply Current	I _{SUPPLY}	V _{OUT} = 2.5V, R _L = ∞	-	6	7	mA
Unity Gain Bandwidth Product	f _T		10	14	-	MHz
Slew Rate	SR		4	5	-	V/ μ s
Output Current						
Source to opposite supply	I _{SOURCE}		4	5.5	-	mA
Sink to opposite supply	I _{SINK}		1.0	1.2	-	mA
Open Loop Gain	A _{OL}	0.5V to 3.5V, R _L = 10k Ω	80	90	-	dB

NOTE:

- This is the lowest value that can be tested reliably. Almost all devices will be <10pA.

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Electrical Specifications $T_A = -55^{\circ}\text{C}$ to 125°C , $V_+ = 5\text{V}$, $V_- = \text{GND}$

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$ V_{IO} $		-	6	25	mV
Input Offset Current	$ I_{IO} $		-	550	5500	pA
Input Current	I_I		-	550	11000	pA
Common Mode Input Range	V_{ICR}		3.5	-0.5 to 3.7	0	V
Common Mode Rejection Ratio	CMRR	$V_{ICR} = 0\text{V}$ to 3.5V	50	65	-	dB
Power Supply Rejection Ratio	PSRR	$\Delta V = 2\text{V}$	58	75	-	dB
Positive Output Voltage Swing	V_{OM+}	$R_L = 2\text{k}\Omega$ to GND	3.8	4.2	-	V
Negative Output Voltage Swing	V_{OM-}	$R_L = 2\text{k}\Omega$ to GND	-	0.08	0.11	V
Total Supply Current	I_{SUPPLY}	$V_{OUT} = 2.5\text{V}$	-	9	11	mA
Unity Gain Bandwidth Product	f_T		8	12	-	MHz
Slew Rate	SR		3	5	-	V/ μs
Output Current						
Source to opposite supply	I_{SOURCE}		4	5.5	-	mA
Sink to opposite supply	I_{SINK}		0.8	1.2	-	mA
Open Loop Gain	A_{OL}	0.5V to 3.5V , $R_L = 10\text{k}\Omega$	80	90	-	dB

Electrical Specifications $T_A = 25^{\circ}\text{C}$, $V_{SUPPLY} = \pm 7.5\text{V}$

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$ V_{IO} $		-	5	25	mV
Input Offset Current	$ I_{IO} $		-	0.5	50 (Note 4)	pA
Input Current	I_I		-	1	50 (Note 4)	pA
Common Mode Input Range	V_{ICR}		5.8	-7.8 to 6.0	-7.5	V
Common Mode Rejection Ratio	CMRR	$V_{ICR} = 0\text{V}$ to 13.3V	60	70	-	dB
Power Supply Rejection Ratio	PSRR	$\Delta V = 1\text{V}$	60	76	-	dB
Positive Output Voltage Swing	V_{OM+}	$R_L = 2\text{k}\Omega$ to GND	6.3	6.5	-	V
		$R_L = 10\text{k}\Omega$ to GND	6.4	6.6	-	V
Negative Output Voltage Swing	V_{OM-}	$R_L = 2\text{k}\Omega$ to GND	-	-2.6	-2	V
		$R_L = 10\text{k}\Omega$ to GND	-	-7.3	-7.1	V
Total Supply Current	I_{SUPPLY}	$V_{OUT} = \text{GND}$, $R_L = \infty$	-	10	12	mA
Unity Gain Bandwidth Product	f_T		12	16	-	MHz
Slew Rate	SR		4	7	-	V/ μs
Output Current						
Source to opposite supply	I_{SOURCE}		6.2	6.8	-	mA
Sink to opposite supply	I_{SINK}		1	1.4	-	mA
Open Loop Gain	A_{OL}	-5V to $+5\text{V}$, $R_L = 10\text{k}\Omega$	80	90	-	dB

NOTE:

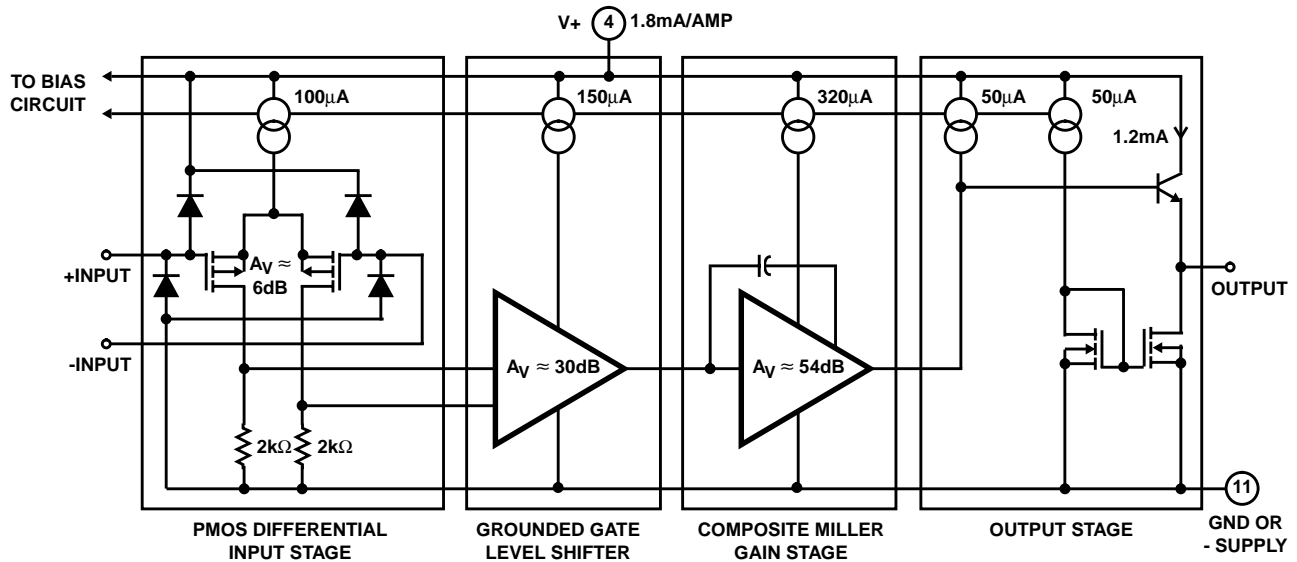
- This is the lowest value that can be tested reliably. Almost all devices will be $<10\text{pA}$.

CA5470

Electrical Specifications $T_A = -55^{\circ}\text{C}$ to 125°C , $V_{\text{SUPPLY}} = \pm 7.5\text{V}$

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Input Offset Voltage	$ V_{IO} $		-	5	30	mV	
Input Offset Current	$ I_{IO} $		-	550	5500	pA	
Input Current	I_I		-	1100	11000	pA	
Common Mode Input Range	V_{ICR}		5.8	-7.8 to 6.0	-7.5	V	
Common Mode Rejection Ratio	CMRR	$V_{ICR} = 0\text{V}$ to 3.5V	58	70	-	dB	
Power Supply Rejection Ratio	PSRR	$\Delta V = 1\text{V}$	60	76	-	dB	
Positive Output Voltage Swing	V_{OM+}	$R_L = 2\text{k}\Omega$ to GND	4.75	5.5	-	V	
		$R_L = 10\text{k}\Omega$ to GND	6.1	6.4	-	V	
Negative Output Voltage Swing	V_{OM-}	$R_L = 2\text{k}\Omega$ to GND	-	-2.6	-2	V	
		$R_L = 10\text{k}\Omega$ to GND	-	-7.3	-7.1	V	
Total Supply Current	I_{SUPPLY}	$V_{\text{OUT}} = \text{GND}$, $R_L = \infty$	-	12	18	mA	
Unity Gain Bandwidth Product	f_T		10	15	-	MHz	
Slew Rate	SR		3	7	-	V/ μs	
Output Current		Source to opposite supply	I_{SOURCE}	6.2	6.8	-	mA
		Sink to opposite supply	I_{SINK}	1	1.4	-	mA
Open Loop Gain	A_{OL}	-5V to $+5\text{V}$, $R_L = 10\text{k}\Omega$	80	90	-	dB	

Block Diagram ($1/4$ of CA5470)



Typical Performance Curve

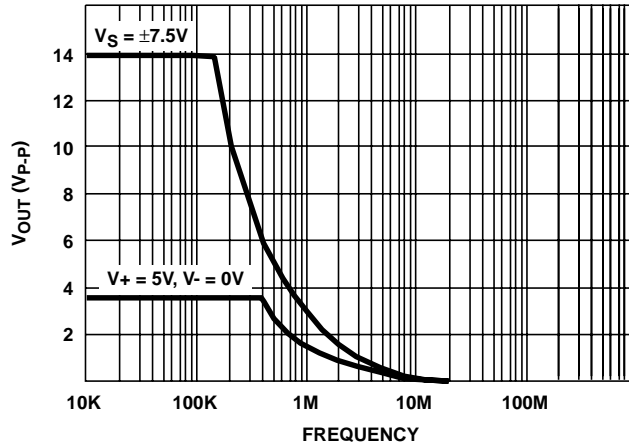
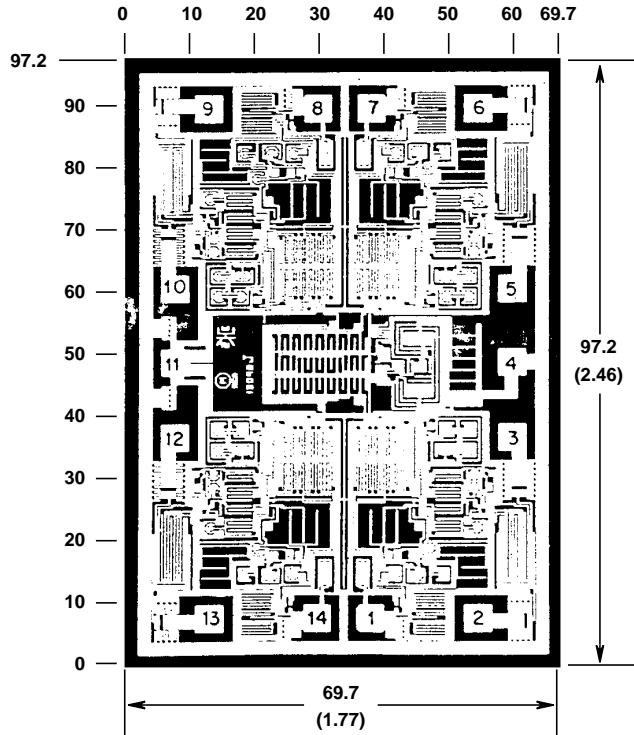


FIGURE 1. MAXIMUM OUTPUT VOLTAGE SWING vs FREQUENCY

Metallization Mask Layout

Dimensions in parentheses are in millimeters and derived from the basic inch dimensions as indicated. Grid graduations are in mils (10^{-3} inch).

The layout represents a chip when it is part of the wafer. When the wafer is cut into chips, the cleavage angles are 57° instead of 90° with respect to the face of the chip. Therefore, the isolated chip is actually 7 mils (0.17mm) larger in both dimensions.



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