Signetics

LM124/224/324/324A/ SA534/LM2902
Low Power Quad Op Amps

Product Specification

Linear Products

DESCRIPTION

The LM124/SA534/LM2902 series consists of four independent, high-gain, internally frequency-compensated operational amplifiers designed specifically to operate from a single power supply over a wide range of voltages.

UNIQUE FEATURES

In the linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

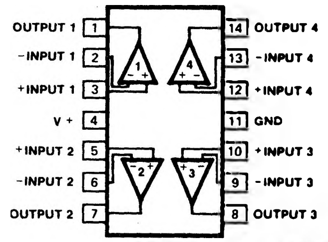
The unity gain crossover frequency and the input bias current are temperature-compensated.

FEATURES

- **Internally frequency-compensated for unity gain**
- **Large DC voltage gain: 100dB**
- **Wide bandwidth (unity gain): 1MHz (temperature-compensated)**
- **Wide power supply range**
  Single supply: $3V_{DC}$ to $30V_{DC}$ or dual supplies: $\pm 1.5V_{DC}$ to $\pm 15V_{DC}$
- **Very low supply current drain: essentially independent of supply voltage (1mW/op amp at $+5V_{DC}$)**
- **Low input biasing current: $45nA_{DC}$ (temperature-compensated)**
- **Low input offset voltage: $2mV_{DC}$ and offset current: $5nA_{DC}$**
- **Differential input voltage range equal to the power supply voltage**
- **Large output voltage: $0V_{DC}$ to $V_{CC} - 1.5V_{DC}$ swing**

PIN CONFIGURATION

D, F, N Packages



TOP VIEW

CD09940S

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
14-Pin Plastic DIP	-55°C to +125°C	LM124N
14-Pin Ceramic DIP	-55°C to +125°C	LM124F
14-Pin Plastic DIP	-25°C to +85°C	LM224N
14-Pin Ceramic DIP	-25°C to +85°C	LM224F
14-Pin Plastic DIP	0 to +70°C	LM324N
14-Pin Ceramic DIP	0 to +70°C	LM324F
14-Pin Plastic SO	0 to +70°C	LM324D
14-Pin Plastic DIP	0 to +70°C	LM324AN
14-Pin Plastic SO	0 to +70°C	LM324AD
14-Pin Plastic DIP	-40°C to +85°C	SA534N
14-Pin Ceramic DIP	-40°C to +85°C	SA534F
14-Pin Plastic SO	-40°C to +85°C	SA534D
14-Pin Plastic SO	-40°C to +85°C	LM2902D
14-Pin Plastic DIP	-40°C to +85°C	LM2902N

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply voltage	32 or ±16	V_{DC}
V_{IN}	Differential input voltage	32	V_{DC}
V_{IN}	Input voltage	-0.3 to +32	V_{DC}
P_D	Maximum power dissipation, $T_A = 25°C$ (still-air)[1] N package F package D package	 1420 1190 1040	 mW mW mW
	Output short-circuit to GND one amplifier[2] $V_{CC} < 15V_{DC}$ and $T_A = 25°C$	Continuous	
I_{IN}	Input current ($V_{IN} < -0.3V$)[3]	50	mA
T_A	Operating ambient temperature range LM324/A LM224 SA534/LM2902 LM124	 0 to +70 -25 to +85 -40 to +85 -55 to +125	 °C °C °C °C
T_{STG}	Storage temperature range	-65 to +150	°C
T_{SOLD}	Lead soldering temperature (10sec max)	300	°C

NOTES:

1. Derate above 25°C, at the following rates:
   F package at 9.5mW/°C
   N package at 11.4mW/°C
   D package at 8.3mW/°C
2. Short-circuits from the output to $V_{CC}+$ can cause excessive heating and eventual destruction. The maximum output current is approximately 40mA, independent of the magnitude of V_{CC}. At values of supply voltage in excess of $+15V_{DC}$ continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction.
3. This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input bias clamps. In addition, there is also lateral NPN parasitic transistor action on the IC chip. This action can cause the output voltages of the op amps to go to the V+ rail (or to ground for a large overdrive) during the time that the input is driven negative.

DC ELECTRICAL CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM124/LM224			LM324/SA534/LM2902			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Offset voltage[1]	$R_S = 0\Omega$		±2	±5		±2	±7	mV
		$R_S = 0\Omega$, over temp.			±7			±9	mV
$\Delta V_{OS}/\Delta T$	Temperature drift	$R_S = 0\Omega$, over temp.		7			7		μV/°C
I_{BIAS}	Input current[2]	$I_{IN}(+)$ or $I_{IN}(-)$		45	150		45	250	nA
		$I_{IN}(+)$ or $I_{IN}(-)$, over temp.		40	300		40	500	nA
$\Delta I_{BIAS}/\Delta T$	Temperature drift	Over temp.		50			50		pA/°C
I_{OS}	Offset current	$I_{IN}(+) - I_{IN}(-)$		±3	±30		±5	±50	nA
		$I_{IN}(+) - I_{IN}(-)$, over temp.			±100			±150	nA
$\Delta I_{OS}/\Delta T$	Temperature drift	Over temp.		10			10		pA/°C
V_{CM}	Common-mode voltage range[3]	$V_{CC} \leq 30V$	0		$V_{CC} - 1.5$	0		$V_{CC} - 1.5$	V
		$V_{CC} \leq 30V$, over temp.	0		$V_{CC} - 2$	0		$V_{CC} - 2$	V
CMRR	Common-mode rejection ratio	$V_{CC} = 30V$	70	85		65	70		dB
V_{OUT}	Output voltage swing	$R_L = 2k\Omega$, $V_{CC} = 30V$, over temp.	26			26			V
V_{OH}	Output voltage high	$R_L \leq 10k\Omega$, $V_{CC} = 30V$, over temp.	27	28		27	28		V
V_{OL}	Output voltage low	$R_L \leq 10k\Omega$, $V_{CC} = 5V$, over temp.		5	20		5	20	mV
I_{CC}	Supply current	$R_L = \infty$, $V_{CC} = 30V$, over temp.		1.5	3		1.5	3	mA
		$R_L = \infty$, $V_{CC} = 5V$, over temp.		0.7	1.2		0.7	1.2	mA
A_{VOL}	Large-signal voltage gain	$V_{CC} = 15V$ (for large V_O swing), $R_L \geq 2k\Omega$	50	100		25	100		V/mV
		$V_{CC} = 15V$ (for large V_O swing), $R_L \geq 2k\Omega$, over temp.	25			15			V/mV
	Amplifier-to-amplifier coupling[5]	f = 1kHz to 20kHz, input referred		−120			−120		dB
PSRR	Power supply rejection ratio	$R_S \leq 0\Omega$	65	100		65	100		dB
I_{OUT}	Output current source	$V_{IN}+ = +1V$, $V_{IN}- = 0V$, $V_{CC} = 15V$	20	40		20	40		mA
		$V_{IN}+ = +1V$, $V_{IN}- = 0V$, $V_{CC} = 15V$, over temp.	10	20		10	20		mA
	sink	$V_{IN}- = +1V$, $V_{IN}+ = 0V$, $V+ = 15V$	10	20		10	20		mA
		$V_{IN}- = +1V$, $V_{IN}+ = 0V$, $V_{CC} = 15V$, over temp.	5	8		5	8		mA
		$V_{IN}- = +1V$, $V_{IN}+ = 0V$, $V_O = 200mV$	12	50		12	50		μA
I_{SC}	Short-circuit current[4]		10	40	60	10	40	60	mA
V_{DIFF}	Differential input voltage[3]				V_{CC}			V_{CC}	V
GBW	Unity gain bandwidth			1			1		MHz
SR	Slew rate			0.3			0.3		V/μs
V_{NOISE}	Input noise voltage	f = 1kHz		40			40		$nV/\sqrt{Hz}$

DC ELECTRICAL CHARACTERISTICS (Continued) $V_{CC} = 5V$, $T_A = 25°C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM324A			UNIT
			Min	Typ	Max	
V_{OS}	Offset voltage[1]	$R_S = 0\Omega$		±2	±3	mV
		$R_S = 0\Omega$, over temp.			±5	mV
$\Delta V_{OS}/\Delta T$	Temperature drift	$R_S = 0\Omega$, over temp.		7	30	μV/°C
I_{BIAS}	Input current[2]	$I_{IN}(+)$ or $I_{IN}(-)$		45	100	nA
		$I_{IN}(+)$ or $I_{IN}(-)$, over temp.		40	200	nA
$\Delta I_{BIAS}/\Delta T$	Temperature drift	Over temp.		50		pA/°C
I_{OS}	Offset current	$I_{IN}(+) - I_{IN}(-)$		±5	±30	nA
		$I_{IN}(+) - I_{IN}(-)$, over temp.			±75	nA
$\Delta I_{OS}/\Delta T$	Temperature drift	Over temp.		10	300	pA/°C
V_{CM}	Common-mode voltage range[3]	$V_{CC} \leqslant 30V$	0		$V_{CC} - 1.5$	V
		$V_{CC} \leqslant 30V$, over temp.	0		$V_{CC} - 2$	V
CMRR	Common-mode rejection ratio	$V_{CC} = 30V$	65	85		dB
V_{OUT}	Output voltage swing	$R_L = 2k\Omega$, $V_{CC} = 30V$, over temp.	26			V
V_{OH}	Output voltage high	$R_L \leqslant 10k\Omega$, $V_{CC} = 30V$, over temp.	27	28		V
V_{OL}	Output voltage low	$R_L \leqslant 10k\Omega$, $V_{CC} = 5V$, over temp.		5	20	mV
I_{CC}	Supply current	$R_L = \infty$, $V_{CC} = 30V$, over temp.		1.5	3	mA
		$R_L = \infty$, $V_{CC} = 5V$, over temp.		0.7	1.2	mA
A_{VOL}	Large-signal voltage gain	$V_{CC} = 15V$ (for large V_O swing), $R_L \geqslant 2k\Omega$	25	100		V/mV
		$V_{CC} = 15V$ (for large V_O swing), $R_L \geqslant 2k\Omega$, over temp.	15			V/mV
	Amplifier-to-amplifier coupling[5]	f = 1kHz to 20kHz, input referred		-120		dB
PSRR	Power supply rejection ratio	$R_S \leqslant 0\Omega$	65	100		dB
I_{OUT}	Output current source	$V_{IN}+ = +1V$, $V_{IN}- = 0V$, $V_{CC} = 15V$	20	40		mA
		$V_{IN}+ = +1V$, $V_{IN}- = 0V$, $V_{CC} = 15V$, over temp.	10	20		mA
	sink	$V_{IN}- = +1V$, $V_{IN}+ = 0V$, $V+ = 15V$	10	20		mA
		$V_{IN}- = +1V$, $V_{IN}+ = 0V$, $V_{CC} = 15V$, over temp.	5	8		mA
		$V_{IN}- = +1V$, $V_{IN}+ = 0V$, $V_O = 200mV$	12	50		μA
I_{SC}	Short-circuit current[4]		10	40	60	mA
V_{DIFF}	Differential input voltage[3]				V_{CC}	V

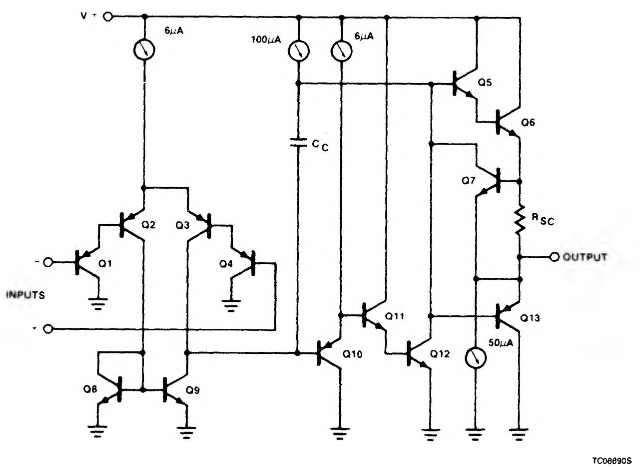
DC ELECTRICAL CHARACTERISTICS (Continued) $V_{CC} = 5V$, $T_A = 25°C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM324A			UNIT
			Min	Typ	Max	
GBW	Unity gain bandwidth			1		MHz
SR	Slew rate			0.3		V/μs
V_{NOISE}	Input noise voltage	f = 1kHz		40		$nV/\sqrt{Hz}$

NOTES:

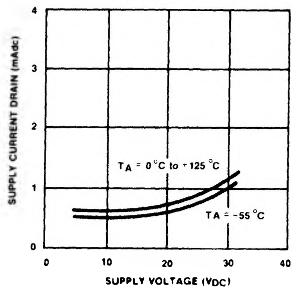
1. $V_O \cong 1.4V_{DC}$, $R_S = 0\Omega$ with V_{CC} from 5V to 30V and over full input common-mode range ($0V_{DC}$+ to V_{CC} − 1.5V).
2. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
3. The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V_{CC} −1.5, but either or both inputs can go to +32V without damage.
4. Short-circuits from the output to V_{CC} can cause excessive heating and eventual destruction. The maximum output current is approximately 40mA independent of the magnitude of V_{CC}. At values of supply voltage in excess of $+15V_{DC}$, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.
5. Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of coupling increases at higher frequencies.

EQUIVALENT SCHEMATIC



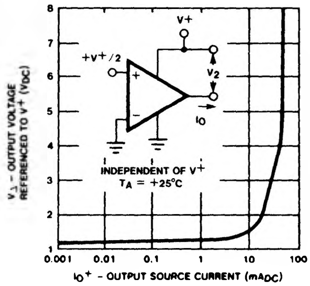
TYPICAL PERFORMANCE CHARACTERISTICS

Supply Current



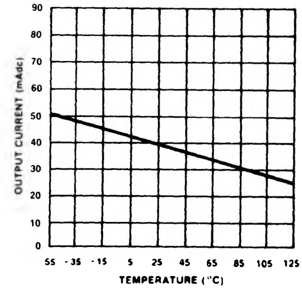
OP05450S

Output Characteristics Current Sourcing



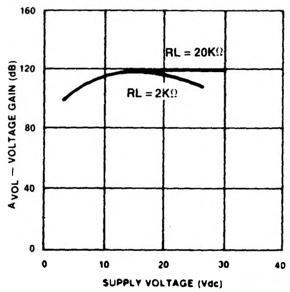
OP05460S

Current Limiting



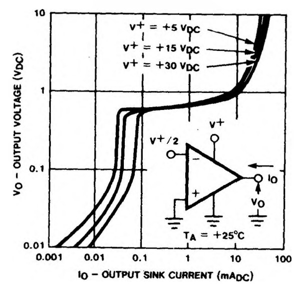
OP05470S

Voltage Gain



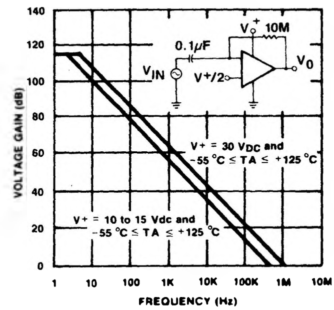
OP05480S

Output Characteristics Current Sinking



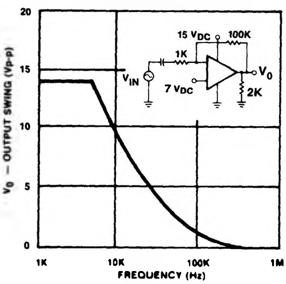
OP05490S

Open-Loop Frequency Response



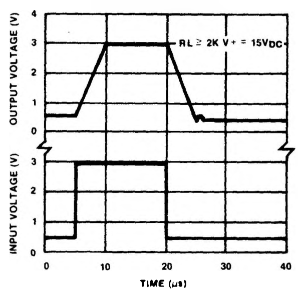
OP05500S

Large-Signal Frequency Response



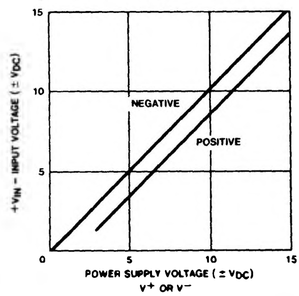
OP05510S

Voltage-Follower Pulse Response



OP05520S

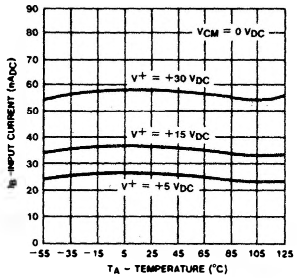
Input Voltage Range



OP05530S

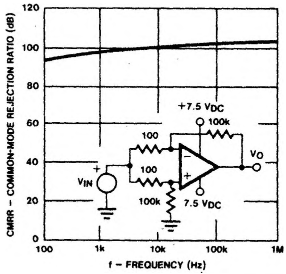
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

Input Current



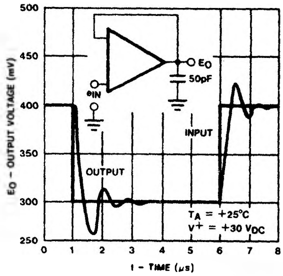
OP05540S

Common-Mode Rejection Ratio



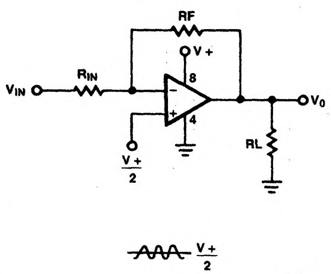
OP05550S

Voltage-Follower Pulse Response (Small-Signal)



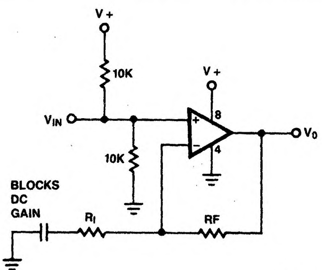
OP05560S

TYPICAL APPLICATIONS



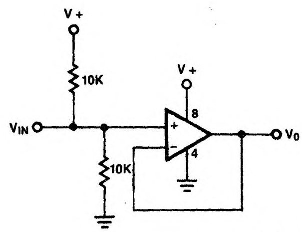
TC08900S

Single Supply Inverting Amplifier



TC08910S

Non-Inverting Amplifier



TC08920S

Input Biasing Voltage-Follower