

LM224/A, LM324/A, LM2902 QUAD OPERATIONAL AMPLIFIER

QUAD OPERATIONAL AMPLIFIERS

14 DIP

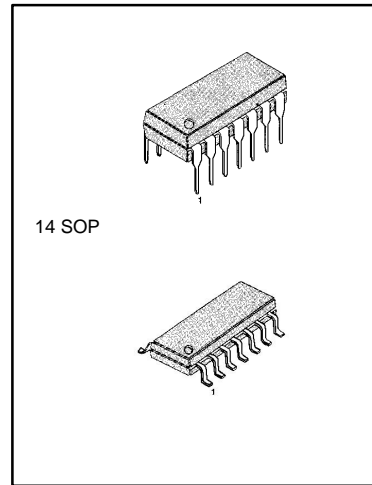
The LM224 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide voltage range.

Operation from split power supplies is also possible so long as the difference between the two supplies is 3 volts to 32 volts.

Application areas include transducer amplifier, DC gain blocks and all the conventional OP amp circuits which now can be easily implemented in single power supply systems.

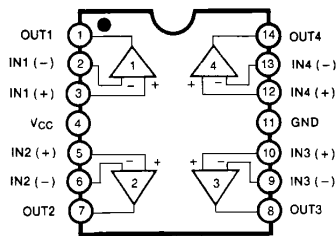
FEATURES

- Internally frequency compensated for unity gain
- Large DC voltage gain: 100dB
- Wide power supply range: LM224/A, LM324/A: 3V ~32V (or $\pm 1.5 \sim 15V$)
LM2902: 3V~26V (or $\pm 1.5V \sim 13V$)
- Input common-mode voltage range includes ground
- Large output voltage swing: 0V DC to $V_{CC} - 1.5V$ DC
- Power drain suitable for battery operation.



14 SOP

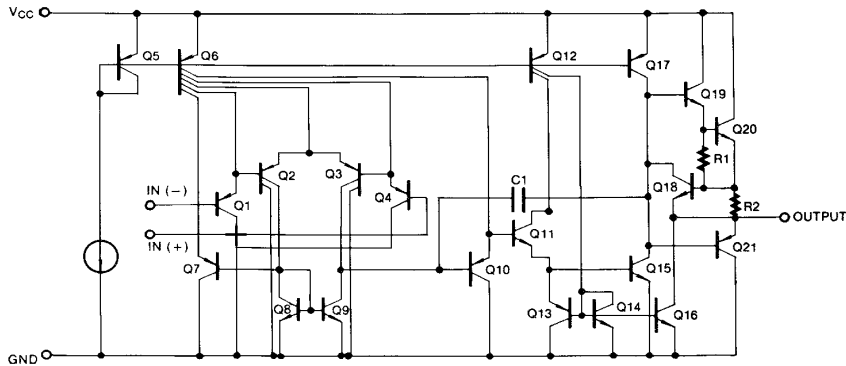
BLOCK DIAGRAM



ORDERING INFORMATION

Device	Package	Operating Temperature
LM324N LM324AN	14 DIP	0 ~ +70°C
LM324M LM324AM	14 SOP	
LM224N LM224AN	14 DIP	-25 ~ +85°C
LM224M LM224AM	14 SOP	
LM2902N	14 DIP	-40 ~ +85°C
LM2902M	14 SOP	

SCHEMATIC DIAGRAM (One Section Only)



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ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	LM224/LM224A	LM324/LM324A	LM2902	Unit
Power Supply Voltage	V_{CC}	± 18 or 32	± 18 or 32	± 13 or 26	V
Differential Input Voltage	$V_{I(DIFF)}$	32	32	26	V
Input Voltage	V_I	-0.3 to + 32	-0.3 to +32	-0.3 to +26	V
Output Short Circuit to GND $V_{CC} \leq 15V$ $T_A = 25^\circ C$ (One Amp)		Continuous	Continuous	Continuous	
Power Dissipation	P_D	570	570	570	mW
Operating Temperature Range	T_{OPR}	-25 ~ +85	0 ~ + 70	-40 ~ + 85	$^\circ C$
Storage Temperature Range	T_{STG}	-65 ~ + 150	-65 ~ + 150	-65 ~ + 150	$^\circ C$

ELECTRICAL CHARACTERISTICS

($V_{CC} = 5.0V$, $V_{EE} = GND$, $T_A = 25^\circ C$, unless otherwise specified)

Characteristic	Symbol	Test Conditions	LM224			LM324			LM2902			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{IO}	$V_{CM} = 0V$ to $V_{CC} = 1.5V$ $V_{O(P)} = 1.4V$, $R_S = 0\Omega$		1.5	5.0		1.5	7.0		1.5	7.0	mV
Input Offset Current	I_{IO}			2.0	30		3.0	50		3.0	50	nA
Input Bias Current	I_{BIAS}			40	150		40	250		40	250	nA
Input Common-Mode Voltage Range	$V_{I(R)}$	$V_{CC} = 30V$ ($V_{CC} = 26V$ for KA2902)	0		$V_{CC} - 1.5$	0	$V_{CC} - 1.5$		0		$V_{CC} - 1.5$	V
Supply Current	I_{CC}	$R_L = \infty$, $V_{CC} = 30V$ (all Amps)		1.0	3		1.0	3		1.0	3	mA
		$R_L = \infty$, $V_{CC} = 5V$ (all Amps) ($V_{CC} = 26V$ for KA2902)		0.7	1.2		0.7	1.2		0.7	1.2	mA
Large Signal Voltage Gain	G_V	$V_{CC} = 15V$, $R_L \geq 2K\Omega$ $V_{O(P)} = 1V$ to 11V	50	100		25	100			100		V/mV
Output Voltage Swing	$V_{O(H)}$	$V_{CC} = 30V$ $V_{CC} = 26V$ for 2902		26		26		22				V
		$R_L = 2K\Omega$ $R_L = 10K\Omega$	27	28		27	28		23	24		V
	$V_{O(L)}$	$V_{CC} = 5V$, $R_L \geq 10K\Omega$		5	20		5	20		5	100	mV
Common-Mode Rejection Ratio	CMRR		70	85		65	75		50	75		dB
Power Supply Rejection Ratio	PSRR		65	100		65	100		50	100		dB
Channel Separation	CS	$f = 1KHz$ to 20KHz		120			120			120		dB
Short Circuit to GND	I_{SC}			40	60		40	60		40	60	mA
Output Current	I_{SOURCE}	$V_{I(+)} = 1V$, $V_{I(-)} = 0V$ $V_{CC} = 15V$, $V_{O(P)} = 2V$	20	40		20	40		20	40		mA
		$V_{I(+)} = 0V$, $V_{I(-)} = 1V$ $V_{CC} = 15V$, $V_{O(P)} = 2V$	10	13		10	13		10	13		mA
	I_{SINK}	$V_{I(+)} = 0V$, $V_{I(-)} = 1V$ $V_{CC} = 15V$, $V_{O(R)} = 200mV$	12	45		12	45					μA
Differential Input Voltage	$V_{I(DIFF)}$				V_{CC}				V_{CC}		V_{CC}	V

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ELECTRICAL CHARACTERISTICS

($V_{CC} = 5.0V$, $V_{EE} = GND$, unless otherwise specified)

The following specification apply over the range of $-25^{\circ}C \leq T_A \leq +85^{\circ}C$ for the LM224; and the $0^{\circ}C \leq T_A \leq +70^{\circ}C$ for the LM324 ; and the $-40^{\circ}C \leq T_A \leq +85^{\circ}C$ for the LM2902

Characteristic	Symbol	Test Conditions	LM224			LM324			LM2902			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{IO}	$V_{ICM} = 0V$ to $V_{CC} = 1.5V$ $V_{O(P)} = 1.4V$, $R_S = 0\Omega$			7.0			9.0			10.0	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$			7.0			7.0			7.0		$\mu V/^{\circ}C$
Input Offset Current	I_{IO}				100			150			200	nA
Input Offset Current Drift	$\Delta I_{IO}/\Delta T$			10			10			10		$\mu A/^{\circ}C$
Input Bias Current	I_{BIAS}				300			500			500	nA
Input Common-Mode Voltage Range	$V_{IC(R)}$	$V_{CC} = 30V$ ($V_{CC} = 26V$ for KA2902)	0		$V_{CC} - 2.0$	0		$V_{CC} - 2.0$	0		$V_{CC} - 2.0$	V
Large Signal Voltage Gain	G_V	$V_{CC} = 15V$, $R_L \geq 2.0K\Omega$ $V_{O(P)} = 1V$ to $11V$	25			15			15			V/mV
Output Voltage Swing	$V_{O(H)}$	$V_{CC} = 30V$ $V_{CC} = 26V$ for 2902	26			26			22			V
	$V_{O(L)}$	$R_L = 2K\Omega$ $R_L = 10K\Omega$	27	28		27	28		23	24		V
Output Current	I_{SOURCE}	$V_{I(+)} = 1V$, $V_{I(-)} = 0V$ $V_{CC} = 15V$, $V_{O(P)} = 2V$	10	20		10	20		10	20		mA
	I_{SINK}	$V_{I(+)} = 0V$, $V_{I(-)} = 1V$ $V_{CC} = 15V$, $V_{O(P)} = 2V$	10	13		5	8		5	8		mA
Differential Input Voltage	$V_{I(DIFS)}$				V_{CC}			V_{CC}			V_{CC}	V

LM224/A, LM324/A, LM2902 QUAD OPERATIONAL AMPLIFIER

ELECTRICAL CHARACTERISTICS

($V_{CC}=50V$, $V_{EE} = GND$, $T_A=25^\circ C$, unless otherwise specified)

Characteristic	Symbol	Test Conditions	LM224A			LM324A			Unit
			Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{IO}	$V_{CM} = 0V$ to $V_{CC} = 1.5V$ $V_{O(P)} = 1.4V$, $R_S = 0 \Omega$		1.0	3.0		1.5	3.0	mV
Input Offset Current	I_{IO}			2	15		3.0	30	nA
Input Bias Current	I_{BIAS}			40	80		40	100	nA
Input Common-Mode Voltage Range	$V_{I(R)}$	$V_{CC} = 30V$	0		$V_{CC} - 1.5$	0		$V_{CC} - 1.5$	V
Supply Current (All Amps)	I_{CC}	$V_{CC} = 30V$		1.5	3		1.5	3	mA
		$V_{CC} = 5V$		0.7	1.2		0.7	1.2	mA
Large Signal Voltage Gain	G_V	$V_{CC} = 15V$, $R_L \geq 2 K\Omega$ $V_{O(P)} = 1V$ to $11V$	50	100		25	100		V/mV
Output Voltage Swing	$V_{O(H)}$	$V_{CC} = 30V$		26			26		V
		$V_{CC} = 26V$ for 2902		27	28		27	28	V
	$V_{O(L)}$	$V_{CC} = 5V$, $R_L \geq 10 K\Omega$		5	20		5	20	mV
Common-Mode Rejection Ratio	CMRR		70	85		65	85		dB
Power Supply Rejection Ratio	PSRR		65	100		65	100		dB
Channel Separation	CS	$f = 1KHz$ to $20KHz$		120			120		dB
Short Circuit to GND	I_{SC}			40	60		40	60	mA
Output Current	I_{SOURCE}	$V_{I(+)} = 1V$, $V_{I(-)} = 0V$ $V_{CC} = 15V$	20	40		20	40		mA
		$V_{I(+)} = 0V$, $V_{I(-)} = 1V$ $V_{CC} = 15V$, $V_{O(P)} = 2V$	10	20		10	20		mA
	I_{SINK}	$V_{I(+)} = 0V$, $V_{I(-)} = 1V$ $V_{CC} = 15V$, $V_{O(P)} = 200mV$	12	50		12	50		μA
Differential Input Voltage	$V_{I(DIFF)}$				V_{CC}			V_{CC}	V

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ELECTRICAL CHARACTERISTICS

($V_{CC} = 5.0V$, $V_{EE} = GND$, unless otherwise specified)

The following specification apply over the range of $-25^{\circ}C \leq T_A \leq +85^{\circ}C$ for the LM224A; and the $0^{\circ}C \leq T_A \leq +70^{\circ}C$ for the LM324A

Characteristic	Symbol	Test Conditions	LM224A			LM324A			Unit
			Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{IO}	$V_{CM} = 0V$ to $V_{CC} = 1.5V$ $V_{O(P)} = 1.4V$, $R_S = 0\Omega$			4.0			5.0	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$			7.0	20		7.0	30	$\mu V/^{\circ}C$
Input Offset Current	I_{IO}				30			75	nA
Input Offset Current Drift	$\Delta I_{IO}/\Delta T$			10	200		10	300	$pA/^{\circ}C$
Input Bias Current	I_{BIAS}			40	100		40	200	nA
Input Common-Mode Voltage Range	$V_{I(R)}$	$V_{CC} = 30V$	0		$V_{CC} - 2.0$	0		$V_{CC} - 2.0$	V
Large Signal Voltage Gain	G_V	$V_{CC} = 15V$, $R_L \geq 2.0K\Omega$	25			15			V/mV
Output Voltage Swing	$V_{O(P-P)}$	$V_{CC} = 30V$							V
		$R_L = 2K\Omega$	26			26			
		$R_L = 10K\Omega$	27	28		27	28		
		$V_{CC} = 5V$, $R_L \geq 10K\Omega$		5	20		5	20	mA
Output Current	I_{SOURCE}	$V_{I(+)} = 1V$, $V_{I(-)} = 0V$ $V_{CC} = 15V$	10	20		10	20		mA
	I_{SINK}	$V_{I(+)} = 0V$, $V_{I(-)} = 1V$ $V_{CC} = 15V$	5	8		5	8		mA
Differential Input Voltage	$V_{I(DIFF)}$				V_{CC}			V_{CC}	V

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TYPICAL PERFORMANCE CHARACTERISTICS

Fig. 1 INPUT VOLTAGE RANGE

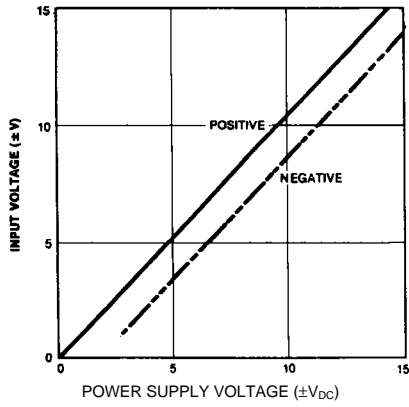


Fig. 2 INPUT CURRENT

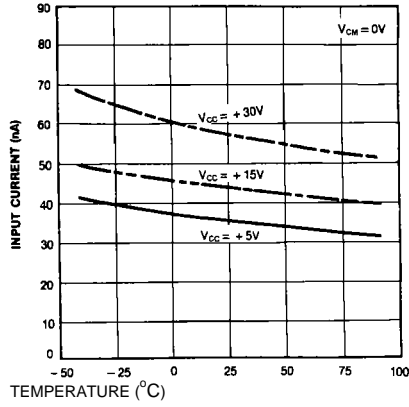


Fig. 3 SUPPLY CURRENT

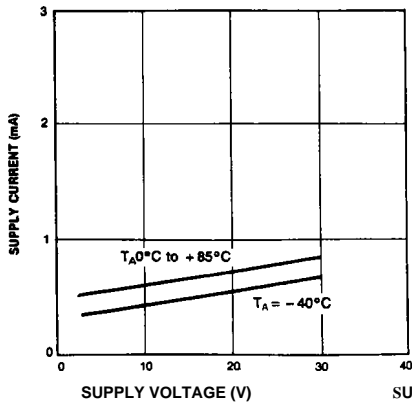


Fig. 4 VOLTAGE GAIN

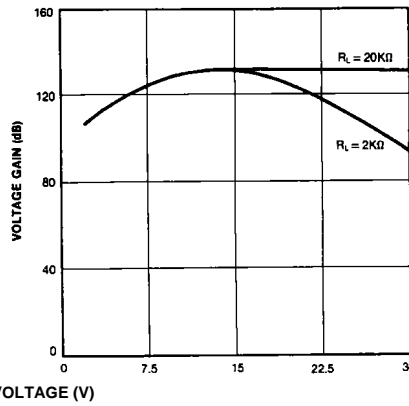


Fig. 5 OPEN LOOP FREQUENCY RESPONSE

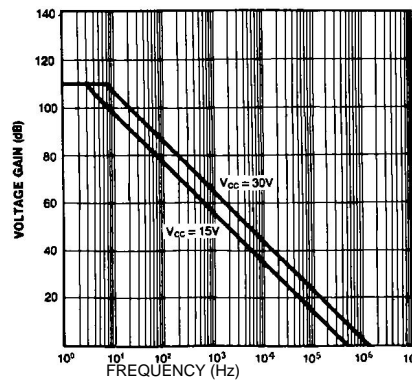
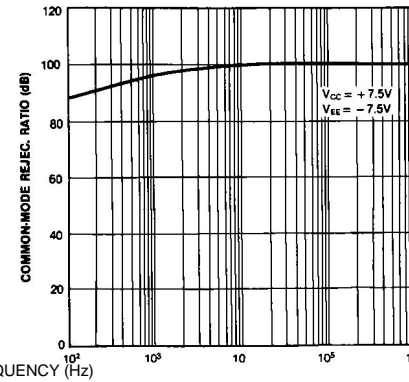


Fig. 6 COMMON-MODE REJECTION RATIO



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Fig. 7 SLEW RATE

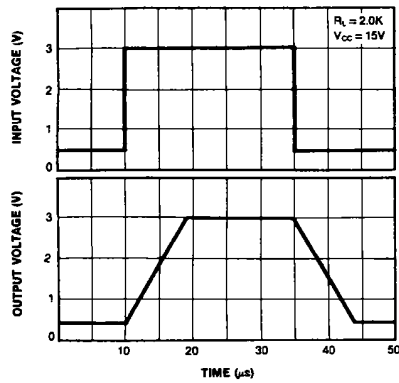


Fig. 8 VOLTAGE FOLLOWER PULSE

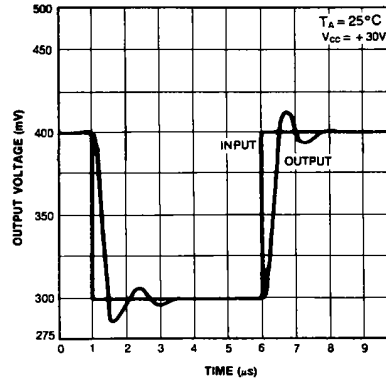


Fig. 9 LARGE SIGNAL FREQUENCY RESPONSE

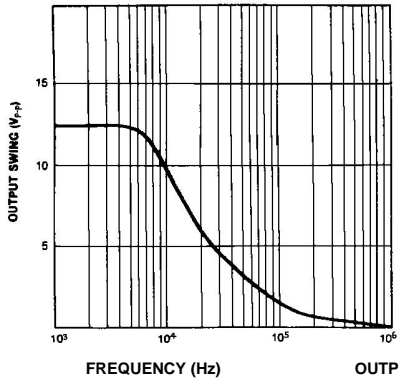


Fig. 10 OUTPUT CHARACTERISTICS

CURRENT SOURCING

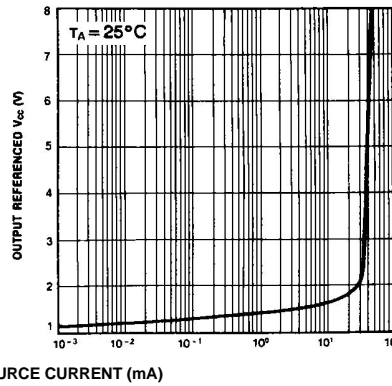


Fig. 11 OUTPUT CHARACTERISTICS CURRENT SINKING

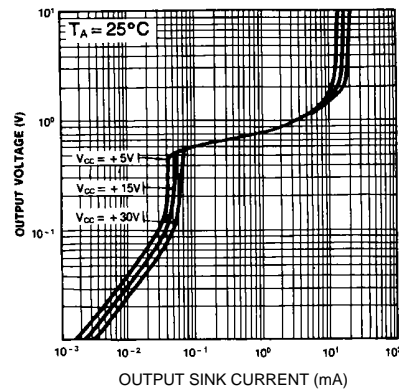
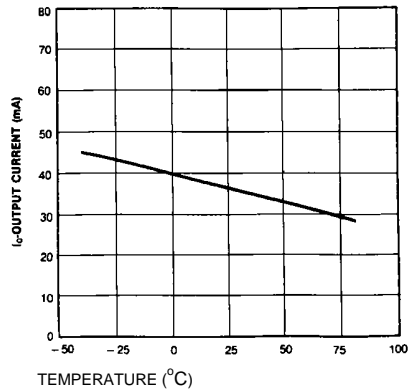


Fig. 12 CURRENT LIMITING



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FACT™	QS™
FACT Quiet Series™	Quiet Series™
FAST®	SuperSOT™-3
FASTr™	SuperSOT™-6
GTO™	SuperSOT™-8
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PRODUCT STATUS DEFINITIONS

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