19-0133; Rev. 1; 6/93

MAXIM

Dual/Quad Precision Op Amps

General Description

The Maxim LT1013 is a precision dual op amp that upgrades the performance of popular devices such as the MC1458/MC1558, LM158 and OP221. The Maxim LT1014 is a precision quad op amp that directly upgrades designs in the industry-standard 14-pin DIP configuration and has specifications similar to the LT1013.

Precision specifications include: 40µV offset voltage, 0.3µV/°C drift (TCV_{OS}), 117dB CMRR, and 120dB PSRR. While supply current is typically only 350µA per amplifier, the outputs can source and sink more than 20mA.

Both the LT1013 and the LT1014 can be operated from a single +5V power supply. The input voltage range includes ground and the outputs swing to within a few millivolts of ground.

Applications

Battery-Powered Precision Instrumentation
- Strain-Gauge Signal Conditioners
- Thermocouple Amplifiers
- Instrumentation Amplifiers

4mA to 20mA Current-Loop Transmitters

Multiple-Limit Threshold Detection

Active Filters

Multiple Gain Blocks

Features

- **Single-Supply Operation**
  Input Voltage Range Extends to Ground
  Output Swings to Ground while Sinking Current
- **150µV Max Offset Voltage**
- **Low Drift: 2µV/°C Max**
- **0.8nA Max Offset Current**
- **Guaranteed High Gain**
  5mA Load Current: 1.5 Million Min
  17mA Load Current: 0.8 Million Min
- **500µA Max Supply Current per Amplifier**
- **Low Voltage Noise: 0.1Hz to 10Hz, 0.55μV_{p-p}**
- **Lower Current Noise than OP07: 0.07 pA/$\sqrt{Hz}$**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
LT1013CN8	0°C to +70°C	8 Plastic DIP
LT1013DN8	0°C to +70°C	8 Plastic DIP
LT1013DS8	0°C to +70°C	8 SO
LT1013DC/D	0°C to +70°C	Dice*
LT1013IN8	-40°C to +85°C	8 Plastic DIP
LT1013IS8	-40°C to +85°C	8 SO
LT1013AMJ8	-55°C to +125°C	8 CERDIP**
LT1013MJ8	-55°C to +125°C	8 CERDIP**

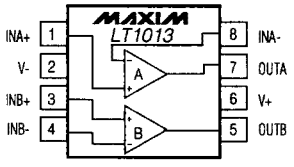
Ordering Information continued on last page.

** Dice are specified at T_A = +25°C, D.C. parameters only.*

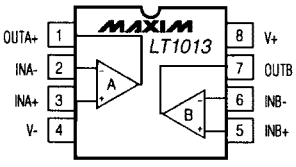
***Contact factory for availability and processing to MIL-STD-883.*

Pin Configurations

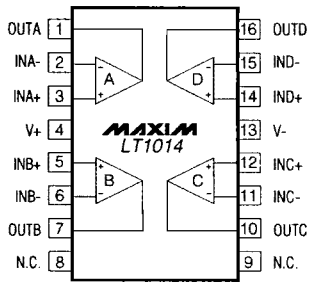
TOP VIEW



SO



DIP



Wide SO

NOTE: SO PIN CONFIGURATION DIFFERS FROM DIP.

Pin Configurations continued on last page.

Dual/Quad Precision Op Amps

ABSOLUTE MAXIMUM RATINGS

Supply Voltage ..... ±22V
Input Voltage ..... Equal to Positive Supply Voltage
..... 5V Below Negative Supply Voltage
Output Short-Circuit Duration ..... Continuous
Differential Input Voltage ..... ±30V
Continuous Power Dissipation (T_A = +70°C)
8-Pin Plastic DIP (derate 9.09mW/°C above +70°C) 727mW
8-Pin SO (derate 5.88mW/°C above +70°C) 471mW
8-Pin CERDIP (derate 8.00mW/°C above +70°C) 640mW
14-Pin Plastic DIP (derate 10.00mW/°C above +70°C) .. 800mW
14-Pin CERDIP (derate 9.09mW/°C above +70°C) 727mW
16-Pin Wide SO (derate 9.52mW/°C above +70°C) 762mW
Operating Temperature Ranges:
LT1013/LT1014C_ ..... 0°C to +70°C
LT1013/LT1014I_ ..... -40°C to +85°C
LT1013/LT1014AM_,M_ ..... -55°C to +125°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10sec) ..... +300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_S = ±15V, V_{CM} = 0V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	LT1013AM LT1014AM			LT1013C/D/I/M LT1014C/D/I/M			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	LT1013		40	150		60	300	µV
		LT1014		50	180		60	300	
		LT1013D/I, LT1014D/I					200	800	
Long-Term Input Offset Voltage Stability				0.4			0.5		µV/Mo.
Input Offset Current	I_{OS}			0.15	0.80		0.2	1.5	nA
Input Bias Current	I_B			12	20		15	30	nA
Input Noise Voltage	e_n	0.1Hz to 10Hz		0.55			0.55		μV_{p-p}
Input Noise-Voltage Density	e_n	f_O = 10Hz		24			24		$nV/\sqrt{Hz}$
		f_O = 1000Hz		22			22		
Input Noise-Current Density	i_n	f_O = 10Hz		0.07			0.07		$pA/\sqrt{Hz}$
Input Resistance (Note 1)		Differential	100	400		70	300		MΩ
		Common mode		5			4		GΩ
Large-Signal Voltage Gain	A_{VOL}	V_O = ±10V, R_L = 2kΩ	1.5	8.0		1.2	7.0		V/µV
		V_O = ±10V, R_L = 600Ω	0.8	2.5		0.5	2.0		
Input Voltage Range			+13.5	+13.8		+13.5	+13.8		V
			-15.0	-15.3		-15.0	-15.3		
Common-Mode Rejection Ratio	CMRR	V_{CM} = +13.5V, -15.0V	100	117		97	114		dB

ELECTRICAL CHARACTERISTICS (continued)

(V_S = ±15V, V_{CM} = 0V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	LT1013AM LT1014AM			LT1013C/D/I/M LT1014C/D/I/M			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Power-Supply Rejection Ratio	PSRR	V_S = ±2V to ±18V	103	120		100	117		dB
Channel Separation		V_O = ±10V, R_L = 2kΩ	123	140		120	137		dB
Output Voltage Swing	V_{OUT}	R_L = 2kΩ	±13	±14		±12.5	±14		V
Slew Rate			0.2	0.4		0.2	0.4		V/µs
Supply Current	I_S	Per amplifier		0.35	0.50		0.35	0.55	mA

Note 1: Guaranteed by design.

ELECTRICAL CHARACTERISTICS

(V_S+ = +5V, V_S- = 0V, V_{OUT} = +1.4V, V_{CM} = 0V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	LT1013AM LT1014AM			LT1013C/D/I/M LT1014C/D/I/M			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	LT1013		60	250		90	450	µV
		LT1014		70	280		90	450	
		LT1013D/I, LT1014D/I					250	950	
Input Offset Current	I_{OS}			0.2	1.3		0.3	2.0	nA
Input Bias Current	I_B			15	35		18	50	nA
Large-Signal Voltage Gain	A_{VOL}	V_O = 5mV to 4V, R_L =500Ω		1.0			1.0		V/µV
Input Voltage Range			+3.5	+3.8		+3.5	+3.8		V
			0	-0.3		0	-0.3		
Output Voltage Swing	V_{OUT}	Output low, no load		15	25		15	25	mV
		Output low, 600Ω to ground		5	10		5	10	
		Output low, I_{SINK} = 1mA		220	350		220	350	
		Output high, no load	4.0	4.4		4.0	4.4		V
		Output high, 600Ω to ground	3.4	4.0		3.4	4.0		
Supply Current	I_S	Per amplifier		0.31	0.45		0.32	0.50	mA

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ELECTRICAL CHARACTERISTICS

(V_S = ±15V, V_{CM} = 0V, T_A = -40°C to +85°C for LT1013I and LT1014I, T_A = 0°C to +70°C for LT1013C/D and LT1014C/D, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		LT1013C/D/I LT1014C/D/I MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}	LT1013C, LT1014C			80	400	µV
		LT1013D/I, LT1014D/I			230	1000	
		LT1013C, LT1014C: V_S = 5V, 0V, V_O = 1.4V			110	570	
		LT1013D/I, LT1014D/I: V_S = 5V, 0V; V_O = 1.4V			280	1200	
Input Offset-Voltage Drift	TCV_{OS}	(Note 1)			0.4	2.5	µV/°C
		LT1013D/I, LT1014D/I (Note 1)			0.7	5.0	
Input Offset Current	I_{OS}				0.3	2.8	nA
		V_S = 5V, 0V; V_O = 1.4V			0.5	6.0	
Input Bias Current	I_B				16	38	nA
		V_S = 5V, 0V; V_O = 1.4V			24	90	
Large-Signal Voltage Gain	A_{VOL}	V_O = ±10V, R_L = 2kΩ		0.7	4.0		V/µV
Common-Mode Rejection Ratio	CMRR	V_{CM} = +13.0V, -15.0V		94	113		dB
Power-Supply Rejection Ratio	PSRR	V_S = ±2V to ±18V		97	116		dB
Output Voltage Swing	V_{OUT}	R_L = 2kΩ		±12.0	±13.9		V
		V_S = 5V,0V, R_L = 600Ω	Output low		6	13	mV
			Output high	3.2	3.9		V
Supply Current per Amplifier	I_S				0.37	0.60	mA
		V_S = 5V, 0V, V_O = 1.4V			0.34	0.55	

ELECTRICAL CHARACTERISTICS

(V_S = ±15V, V_{CM} = 0V, T_A = -55°C to +125°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	LT1013AM MIN	LT1013AM TYP	LT1013AM MAX	LT1014AM MIN	LT1014AM TYP	LT1014AM MAX	LT1013M LT1014M MIN	LT1013M LT1014M TYP	LT1013M LT1014M MAX	UNITS
Input Offset Voltage	V_{OS}			80	300		90	350		110	550	µV
		V_S = 5V, 0V, V_O = 1.4V; T_A = -55°C to +100°C (Note 2)		80	450		90	480		100	750	
		V_S = 5V, 0V, V_O = 1.4V; T_A = +125°C, V_{CM} = 0.1V		120	450		150	480		200	750	
		V_S = 5V, 0V, V_O = 1.4V; T_A = +125°C, V_{CM} = 0V		250	900		300	960		400	1500	
Input Offset-Voltage Drift	TCV_{OS}	(Note 1)		0.4	2.0		0.4	2.0		0.5	2.5	µV/°C
Input Offset Current	I_{OS}			0.3	2.5		0.3	2.8		0.4	5.0	nA
		V_S = 5V, 0V; V_O = 1.4V		0.6	6.0		0.7	7.0		0.9	10.0	
Input Bias Current	I_B			15	30		15	30		18	45	nA
		V_S = 5V, 0V; V_O = 1.4V		20	80		25	90		28	120	
Large-Signal Voltage Gain	A_{VOL}	V_O = ±10V, R_L = 2kΩ	0.5	2.0		0.4	2.0		0.25	2.0		V/µV
Common-Mode Rejection Ratio	CMRR	V_{CM} = +13.0V, -14.9V	97	114		96	114		94	113		dB
Power-Supply Rejection Ratio	PSRR	V_S = ±2V to ±18V	100	117		100	117		97	116		dB
Output Voltage Swing	V_{OUT}	R_L = 2kΩ	±12.0	±13.8		±12.0	±13.8		±11.5	±13.8		V
		V_S = 5V,0V, R_L = 600Ω to ground; Output low		6	15		6	15		6	18	mV
		V_S = 5V,0V, R_L = 600Ω to ground; Output high	3.2	3.8		3.2	3.8		3.1	3.8		V
Supply Current per Amplifier	I_S			0.38	0.60		0.38	0.60		0.38	0.70	mA
		V_S = 5V, 0V; V_O = 1.4V		0.34	0.55		0.34	0.55		0.34	0.65	

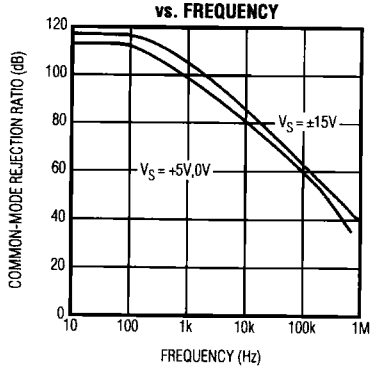
Note 1: Guaranteed by design.
Note 2: This parameter is guaranteed by design and is not tested.

Dual/Quad Precision Op Amps

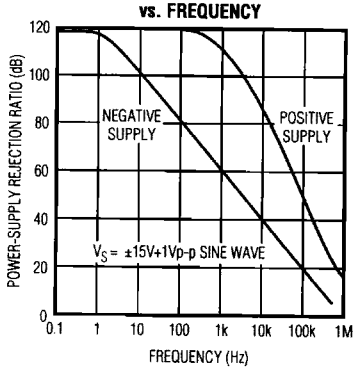
Typical Operating Characteristics

(T_A=+25°C, unless otherwise noted.)

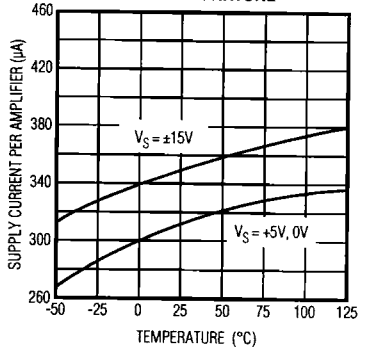
COMMON-MODE REJECTION RATIO vs. FREQUENCY



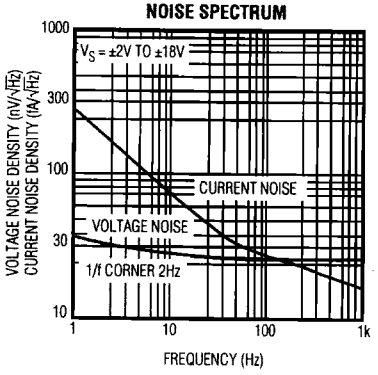
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



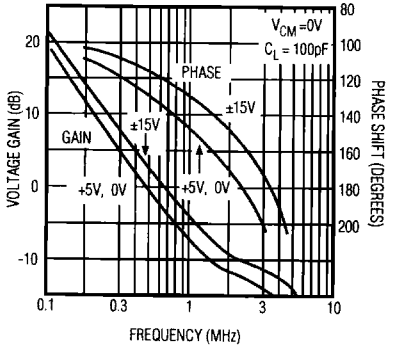
SUPPLY CURRENT vs. TEMPERATURE



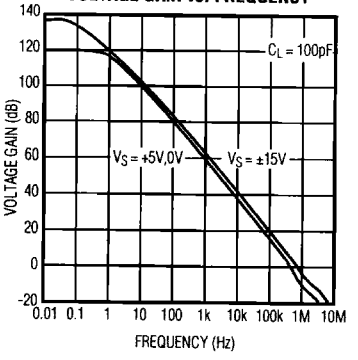
NOISE SPECTRUM



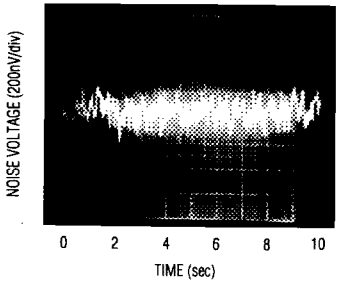
GAIN, PHASE vs. FREQUENCY



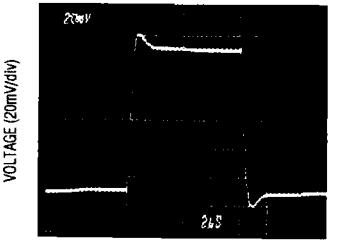
VOLTAGE GAIN vs. FREQUENCY



0.1Hz to 10Hz NOISE

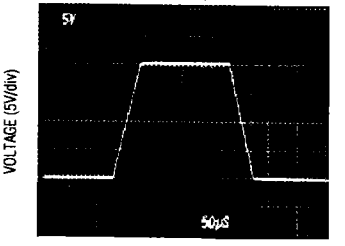


SMALL-SIGNAL TRANSIENT RESPONSE (V_S = ±15V)



A_V = +1

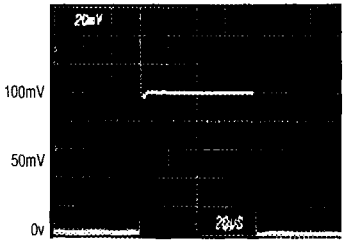
LARGE-SIGNAL TRANSIENT RESPONSE (V_S = ±15V)



A_V = +1

Typical Operating Characteristics (continued)

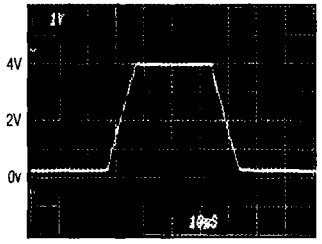
SMALL-SIGNAL TRANSIENT RESPONSE (V_S = 5V, 0V)



TIME (20µs/div)

A_V = +1
R_L = 600Ω to GND

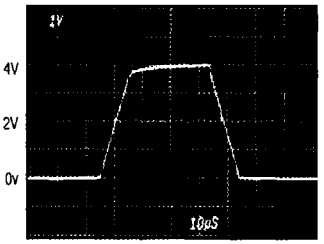
LARGE-SIGNAL TRANSIENT RESPONSE (V_S = 5V, 0V)



TIME (10µs/div)

A_V = +1
R_L = 4.7kΩ to 5V

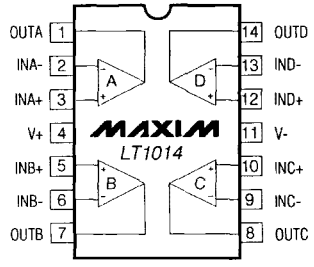
LARGE-SIGNAL TRANSIENT RESPONSE (V_S = 5V, 0V)



TIME (10µs/div)

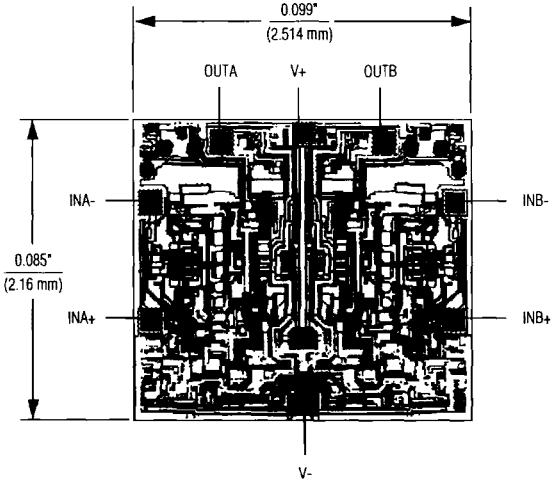
A_V = +1
No load

Pin Configurations (continued)



DIP

Chip Topography



Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
LT1014CN	0°C to +70°C	14 Plastic DIP
LT1014DS	0°C to +70°C	16 Wide SO
LT1014DN	0°C to +70°C	14 Plastic DIP
LT1014IN	-40°C to +85°C	14 Plastic DIP
LT1014IS	-40°C to +85°C	16 Wide SO
LT1014AMJ	-55°C to +125°C	14 CERDIP**
LT1014MJ	-55°C to +125°C	14 CERDIP**

***Contact factory for availability and processing to MIL-STD-883.*