19-0133; Rev. 3; 4/98

MAXIM

Dual/Quad Precision Op Amps

General Description

The Maxim MXL1013 is a precision dual op amp that upgrades the performance of popular devices such as the MC1458/MC1558, LM158 and OP221. The Maxim MXL1014 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. The MXL1013 and MXL1014 are pin compatible with industry standards such as the LT1013 and LT1014.

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 MXL1013 and the MXL1014 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/√Hz**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MXL1013CN8	0°C to +70°C	8 Plastic DIP
MXL1013DN8	0°C to +70°C	8 Plastic DIP
MXL1013DS8	0°C to +70°C	8 SO
MXL1013DC/D	0°C to +70°C	Dice*
MXL1013IN8	-40°C to +85°C	8 Plastic DIP
MXL1013IS8	-40°C to +85°C	8 SO
MXL1013AMJ8	-55°C to +125°C	8 CERDIP**
MXL1013MJ8	-55°C to +125°C	8 CERDIP**

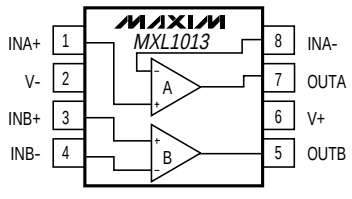
Ordering Information continued on last page.

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

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

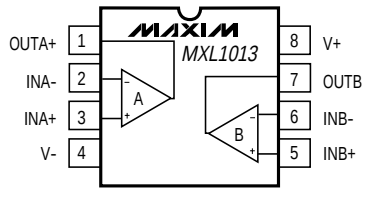
Pin Configurations

TOP VIEW

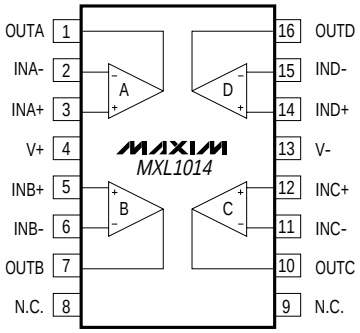


SO

NOTE: SO PIN CONFIGURATION DIFFERS FROM DIP.



DIP



Wide SO

Pin Configurations continued on last page.

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:
MXL1013/MXL1014C_ .....0°C to +70°C
MXL1013/MXL1014I_.....-40°C to +85°C
MXL1013/MXL1014AM_,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 (Note 1)

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

PARAMETER	SYMBOL	CONDITIONS	MXL1013AM MXL1014AM			MXL1013C/D/I/M MXL1014C/D/I/M			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	MXL1013		40	150		60	300	µV
		MXL1014		50	180		60	300	
		MXL101_D/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 2)		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) (Note 1)

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

PARAMETER	SYMBOL	CONDITIONS	MXL1013AM MXL1014AM			MXL1013C/D/I/M MXL1014C/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: When amplifier is sinking current at the output a minimum load of 1kΩ is recommended.
Note 2: Guaranteed by design.

ELECTRICAL CHARACTERISTICS (Note 1)

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

PARAMETER	SYMBOL	CONDITIONS	MXL1013AM MXL1014AM			MXL1013C/D/I/M MXL1014C/D/I/M			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	MXL1013		60	250		90	450	µV
		MXL1014		70	280		90	450	
		MXL101_D/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

ELECTRICAL CHARACTERISTICS (Note 1)

(V_S = ±15V, V_{CM} = 0V, T_A = -40°C to +85°C for MXL1013I and MXL1014I, T_A = 0°C to +70°C for MXL1013C/D and MXL1014C/D, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MXL1013C/D/I MXL1014C/D/I MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}	MXL101_C			80	400	µV
		MXL101_D/I			230	1000	
		MXL101_C: V_S = 5V, 0V, V_O = 1.4V			110	570	
		MXL101_D/I: V_S = 5V, 0V; V_O =1.4V			280	1200	
Input Offset-Voltage Drift	TCV_{OS}	(Note 2)			0.4	2.5	µV/°C
		MXL101_D/I (Note 2)			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 (Note 1)

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

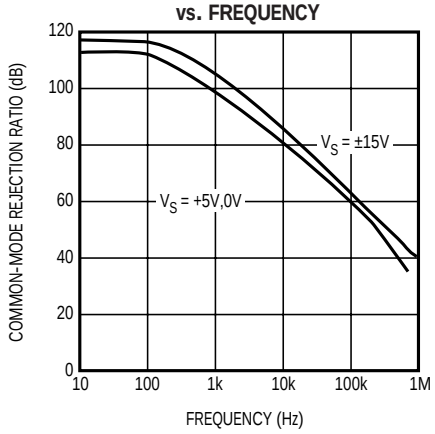
PARAMETER	SYMBOL	CONDITIONS		MXL1013AM MIN	MXL1013AM TYP	MXL1013AM MAX	MXL1014AM MIN	MXL1014AM TYP	MXL1014AM MAX	MXL1013M MXL1014M MIN	MXL1013M MXL1014M TYP	MXL1013M MXL1014M MAX	UNITS
Input Offset Voltage	V_{OS}				80	300		90	350		110	550	µV
		V_S = 5V, 0V, V_O = 1.4V	T_A = -55°C to +100°C (Note 3)		80	450		90	480		100	750	
			T_A = +125°C, V_{CM} = 0.1V		120	450		150	480		200	750	
			T_A = +125°C, V_{CM} = 0V		250	900		300	960		400	1500	
Input Offset-Voltage Drift	TCV_{OS}	(Note 2)			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
			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: When amplifier is sinking current at the output, a minimum load of 1kΩ is recommended.
Note 2: Guaranteed by design.
Note 3: This parameter is guaranteed by design and is not tested.

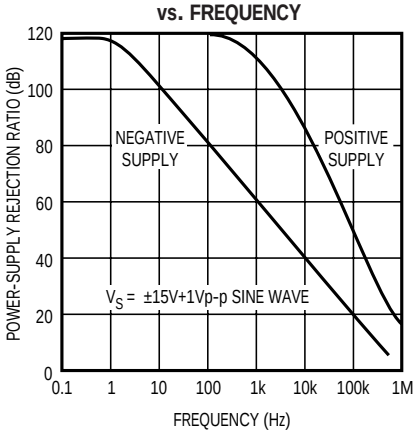
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)

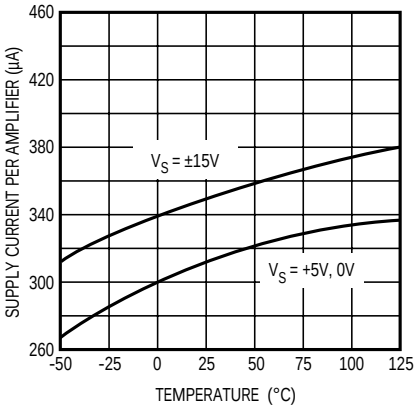
COMMON-MODE REJECTION RATIO vs. FREQUENCY



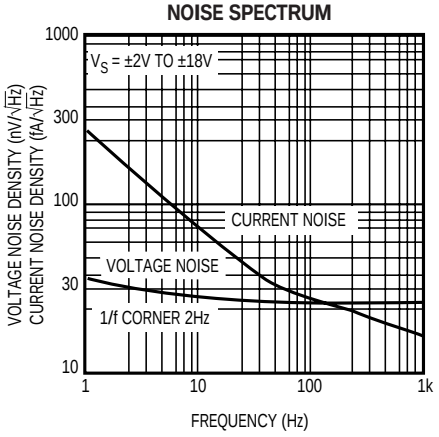
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



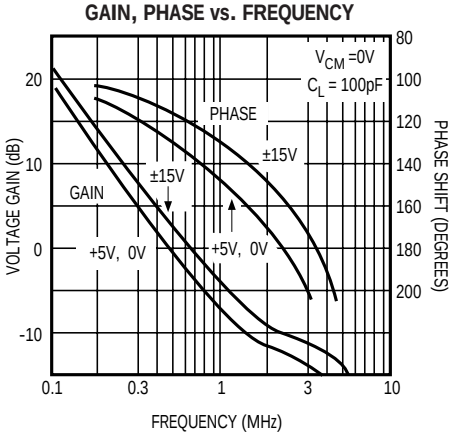
SUPPLY CURRENT vs. TEMPERATURE



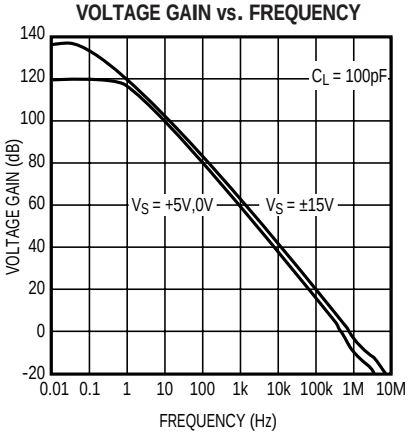
NOISE SPECTRUM



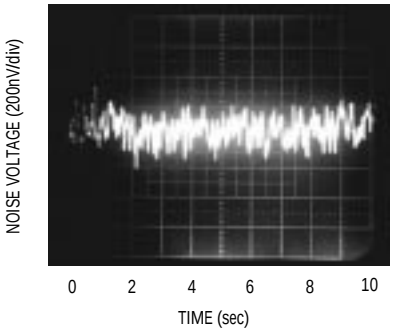
GAIN, PHASE vs. FREQUENCY



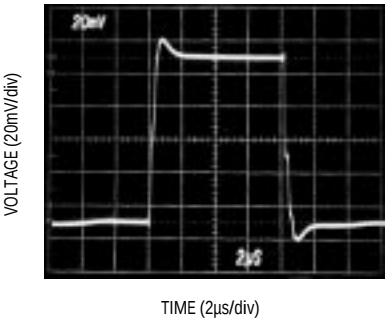
VOLTAGE GAIN vs. FREQUENCY



0.1Hz to 10Hz NOISE

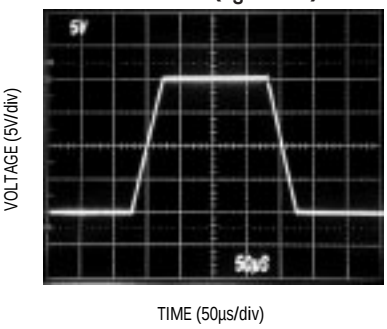


SMALL-SIGNAL TRANSIENT RESPONSE (V_S = ±15V)



A_V = +1

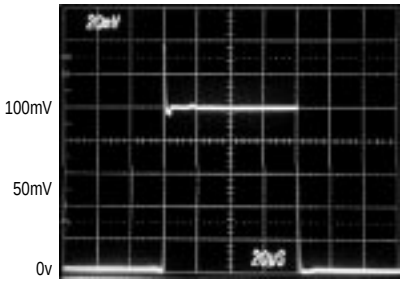
LARGE-SIGNAL TRANSIENT RESPONSE (V_S = ±15V)



A_V = +1

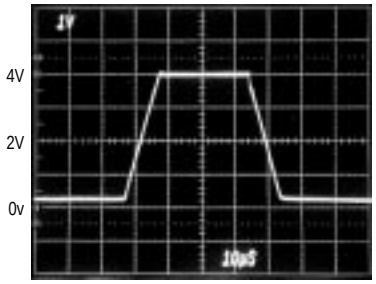
Typical Operating Characteristics (continued)

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



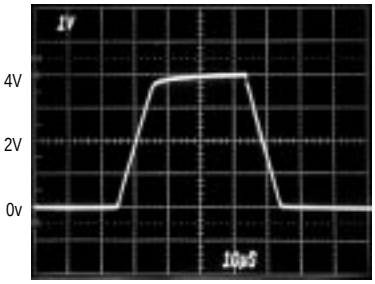
A_V = +1
R_L = 600Ω to GND

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



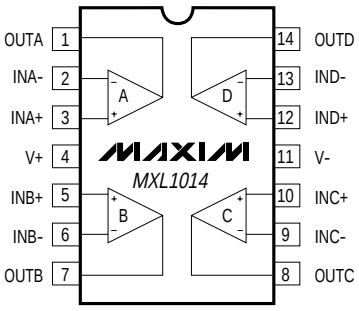
A_V = +1
R_L = 4.7kΩ to 5V

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



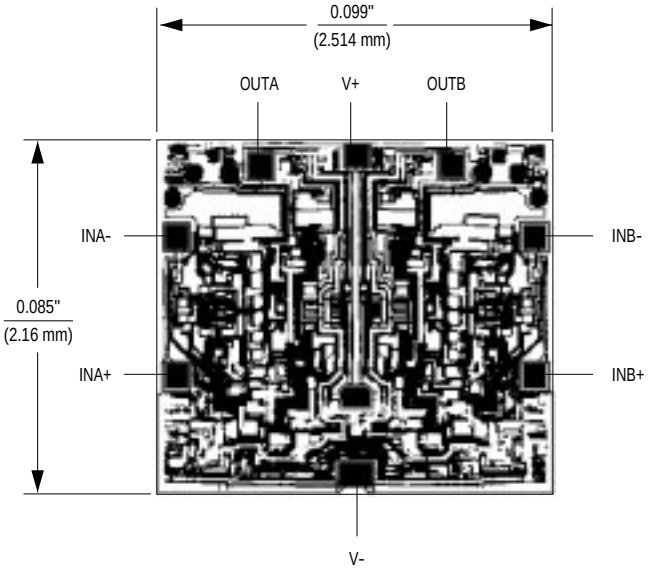
A_V = +1
No load

Pin Configurations (continued)



DIP

Chip Topography



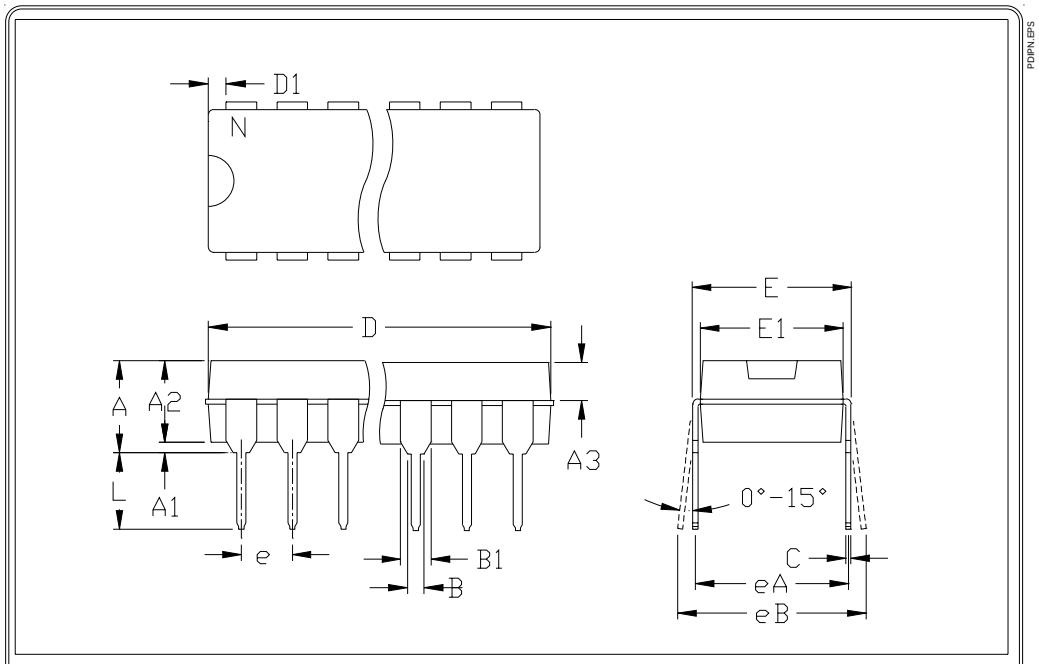
Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
MXL1014CN	0°C to +70°C	14 Plastic DIP
MXL1014DS	0°C to +70°C	16 Wide SO
MXL1014DN	0°C to +70°C	14 Plastic DIP
MXL1014IN	-40°C to +85°C	14 Plastic DIP
MXL1014IS	-40°C to +85°C	16 Wide SO
MXL1014AMJ	-55°C to +125°C	14 CERDIP**
MXL1014MJ	-55°C to +125°C	14 CERDIP**

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

Dual/Quad Precision Op Amps

Package Information



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	---	0.200	---	5.08
A1	0.015	---	0.38	---
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.012	0.20	0.30
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100	---	2.54	---
eA	0.300	---	7.62	---
eB	---	0.400	---	10.16
L	0.115	0.150	2.92	3.81

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS001
D	0.348	0.390	8.84	9.91	8	AB
D	0.735	0.765	18.67	19.43	14	AC
D	0.745	0.765	18.92	19.43	16	AA
D	0.885	0.915	22.48	23.24	18	AD
D	1.015	1.045	25.78	26.54	20	AE
D	1.14	1.265	28.96	32.13	24	AF
D	1.360	1.380	34.54	35.05	28	*5

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC MS001-XX AS SHOWN IN ABOVE TABLE
5. SIMILIAR TO JEDEC MO-058AB
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR SUNNYVALE CA 94086 FAX (408) 737 7194
PROPRIETARY INFORMATION

PACKAGE FAMILY OUTLINE: PDIP .300" (TITLE) | 1/1 | 21-0043 A (DOCUMENT CONTROL NUMBER REV)