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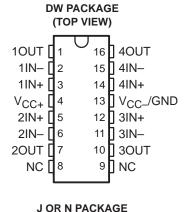
- Single-Supply Operation: Input Voltage Range Extends to Ground, and Output Swings to Ground While Sinking Current
- Input Offset Voltage 300 μV Max at 25°C for LT1014
- Offset Voltage Temperature Coefficient
 2.5 μV/°C Max for LT1014
- Input Offset Current 1.5 nA Max at 25°C for LT1014
- High Gain 1.2 V/ μ V Min (R_L = 2 kΩ), 0.5 V/ μ V Min (R_L = 600 Ω) for LT1014
- Low Supply Current 2.2 mA Max at 25°C for LT 1014
- Low Peak-to-Peak Noise Voltage 0.55 μV Typ
- Low Current Noise 0.07 pA/√Hz Typ

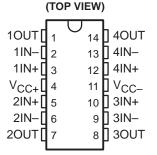
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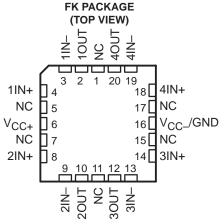
The LT1014, LT1014A, and LT1014D are quad precision operational amplifiers with 14-pin industry-standard configuration. They feature low offset-voltage temperature coefficient, high gain, low supply current, and low noise.

The LT1014, LT1014A, and LT1014D can be operated with both dual ± 15 -V and single 5-V power supplies. The common-mode input voltage range includes ground, and the output voltage can also swing to within a few milivolts of ground. Crossover distortion is eliminated.

The LT1014C and LT1014 AC are characterized for operation from 0°C to 70°C. The LT1014I and LT1014DI are characterized for operation from –40°C to 105°C. The LT1014M, LT1014AM and LT1014DM are characterized for operation over the full military temperature range of –55°C to 125°C.







NC - No internal connection



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



LT1014, LT1014A, LT1014D QUAD PRECISION OPERATIONAL AMPLIFIERS

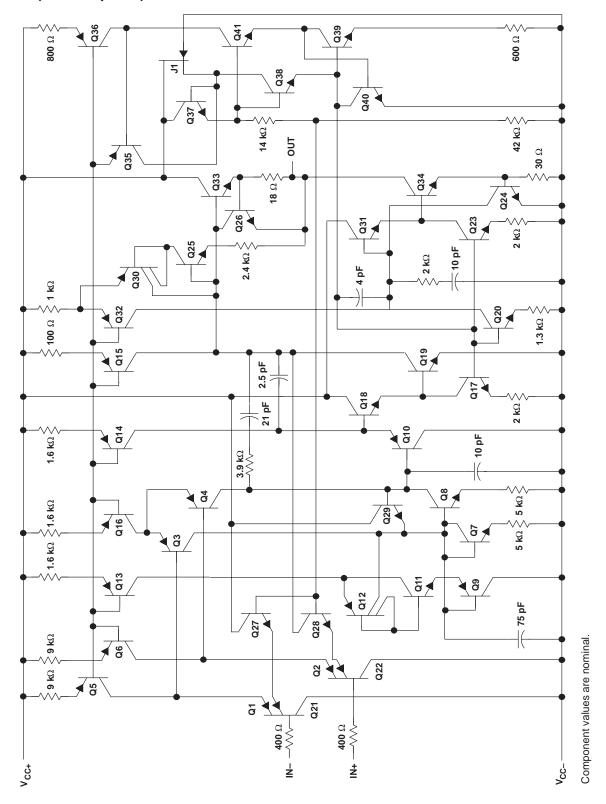
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AVAILABLE OPTIONS

			PACKAGED	DEVICES	
TA	V _{IO} max AT 25°C	SMALL OUTLINE (DW)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)
0°C to 70°C	300 μV 800 μV	— LT1014DDW	_		LT1014CN LT1014DN
-40°C to 105°C	300 μV 800 μV	— LT1014DIDW			LT1014IN LT1014DIN
−55°C to 125°C	180 μV 300 μV 800 μV	— — LT1014DMDW	LT1014AMFK LT1014MFK —	LT1014AMJ LT1014MJ —	— LT1014MN LT1014DMN

 $The \ DW \ package \ is \ available \ taped \ and \ reeled. \ Add \ the \ suffix \ R \ to \ the \ device \ type \ (e.g., LT1014DDWR).$

schematic (each amplifier)





LT1014, LT1014A, LT1014D QUAD PRECISION OPERATIONAL AMPLIFIERS

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage (see Note 1): V _{CC+}	22 V
V _{CC}	–22 V
Differential input voltage (see Note 2)	±30 V
Input voltage range, V _I (any input) (see Note 1)	\dots V _{CC} $$ 5 V to V _{CC+}
Duration of short-circuit current at (or below) T _A = 25°C (see Note 3)	Unlimited
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, T _A : LT1014C, LT1014DC	0°C to 70°C
LT1014I, LT1014DI	–40°C to 105°C
LT1014M, LT1014AM, LT1014DM .	–55°C to 125°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J package .	300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: DW or N pacl	kage 260°C
Case temperature for 60 seconds: FK package	260°C
Storage temperature range, T _{stq}	–65°C to 150°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 under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}

- 2. Differential voltages are at the noninverting input with respect to the inverting input.
- 3. The output may be shorted to either supply.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25^{\circ}C$ POWER RATING	DERATING FACTOR ABOVE T _A = 25°C	T _A = 70°C POWER RATING	T _A = 105°C POWER RATING	T _A = 125°C POWER RATING
DW	1025 mV	8.2 mW/°C	656 mW	369 mW	205 mW
FK	1375 mV	11.0 mW/°C	880 mW	495 mW	275 mW
J	1375 mV	11.0 mW/°C	880 mW	495 mW	275 mW
N	1150 mV	9.2 mW/°C	736 mW	414 mW	230 mW



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electrical characteristics at specified free-air temperature, $V_{CC\pm}=\pm 15$ V, $V_{IC}=0$ (unless otherwise noted)

	DADAMETED	TEST COMPLETIONS			_T1014C		L	T1014D0	;	
	PARAMETER	TEST CONDITIONS	T _A †	MIN	TYP [‡]	MAX	MIN	TYP [‡]	MAX	UNIT
VIO	Input offset voltage	R _S = 50 Ω	25°C		60	300		200	800	μV
VIO	input onset voltage	KS = 50 22	Full range			550			1000	μν
$\alpha_{V_{IO}}$	Temperature coeficient of input offset voltage		Full range		0.4	2.5		0.7	5	μV/°C
	Long-term drift of input offset voltage		25°C		0.5			0.5		μV/mo
110	Input offset current		25°C		0.15	1.5		0.15	1.5	nA
110	input onset current		Full range			2.8			2.8	ПА
I _{IB}	Input bias current		25°C		-12	-30		-12	-30	nA
'IB	input bias current		Full range			-38			-38	ПА
VICR	Common-mode input voltage range		25°C	-15 to 13.5	-15.3 to 13.8		–15 to 13.5	-15.3 to 13.8		V
	input voltage range		Full range	-15 to 13			-15 to 13			
V _{OM}	Maximum peak output	$R_{I} = 2 k\Omega$	25°C	±12.5	±14		±12.5	±14		V
VOM	voltage swing	_	Full range	±12			±12			V
	Large signal differential	$V_0 = \pm 10 \text{ V}, R_L = 600 \Omega$	25°C	0.5	2		0.5	2		
AVD	Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V}, R_L = 2 \text{ k}\Omega$	25°C	1.2	8		1.2	8		V/µV
		VO = ±10 V, RC = 2 R32	Full range	0.7			0.7			
CMRR	Common-mode	$V_{IC} = -15 \text{ V to } 13.5 \text{ V}$	25°C	97	117		97	117		dB
OWNER	rejection ratio	$V_{IC} = -15 \text{ V to } 13 \text{ V}$	Full range	94			94			ub_
١.	Supply-voltage		25°C	100	117		100	117		
ksvr	rejection ratio $(\Delta V_{CC}/\Delta V_{IO})$	$V_{CC\pm} = \pm 2 \text{ V to } \pm 18 \text{ V}$	Full range	97			97			dB
	Channel separation	$V_O = \pm 10 \text{ V}, R_L = 2 \text{ k}\Omega$	25°C	120	137		120	137		dB
^r id	Differential input resistance		25°C	70	300		70	300		МΩ
r _{ic}	Common-mode input resistance		25°C		4			4		GΩ
lcc	Supply current		25°C		0.35	0.55		0.35	0.55	mA
	per amplifier		Full range			0.6			0.6	11171

[†] Full range is 0°C to 70°C. ‡ All typical values are at T_A = 25°C.

LT1014, LT1014A, LT1014D QUAD PRECISION OPERATIONAL AMPLIFIERS

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electrical characteristics at specified free-air temperature, V $_{CC\pm}$ = 5 V, V $_{CC-}$ = 0, V $_{O}$ = 1.4 V, V $_{IC}$ = 0 (unless otherwise noted)

	PARAMETER	TEST COMPITIONS			_T1014C		L	T1014D0	;	UNIT
	PARAMETER	TEST CONDITIONS	T _A †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
V:0	Input offset voltage	$R_S = 50 \Omega$	25°C		90	450		250	950	μV
VIO	input onset voltage	NS = 30 22	Full range			570			1200	μν
lio	Input offset current		25°C		0.2	2		0.2	2	nA
lio	input onset current		Full range			6			6	ш
I _{IB}	Input bias current		25°C		-15	-50		-15	-50	nA
I IIB	input bias current		Full range			-90			-90	ш
	Common-mode		25°C	0	-0.3		0	-0.3		
VICR	input voltage range			to 3.5	to 3.8		to 3.5	to 3.8		V
			Full range	0 to 3			0 to 3			
		Output low, No load	25°C		15	25		15	25	
		Output low,	25°C		5	10		5	10	mV
		$R_L = 600 \Omega$ to GND	Full range			13			13	111.0
Vом	Maximum peak output voltage swing	Output low, I _{sink} = 1 mA	25°C		220	350		220	350	
	voltage swilig	Output high, No load	25°C	4	4.4		4	4.4		
		Output high,	25°C	3.4	4		3.4	4		V
		$R_L = 600 \Omega$ to GND	Full range	3.2			3.2			
AVD	Large-signal differential voltage amplification	$V_O = 5 \text{ mV to 4 V},$ $R_L = 500 \Omega$	25°C		1	·		1		V/µV
loo	Supply current		25°C		0.3	0.5		0.3	0.5	mA
Icc	per amplifier		Full range			0.55			0.55	IIIA

[†] Full range is 0°C to 70°C.

operating characteristics, $V_{CC}\pm$ = ±15 V, V_{IC} = 0, T_{A} = $25^{\circ}C$

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Slew rate		0.2	0.4		V/μs
V	Equivalent input poice veltage	f = 10 Hz		24		->44/11-
V _n	Equivalent input noise voltage	f = 1 kHz		22		nV/√Hz
V _{N(PP)}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 10 Hz		0.55		μV
In	Equivalent input noise current	f = 10 Hz		0.07		pA/√Hz

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electrical characteristics at specified free-air temperature, $V_{CC\pm}=\pm 15$ V, $V_{IC}=0$ (unless otherwise noted)

	DARAMETER		IDITIONIO			LT1014I		L	T1014DI		
	PARAMETER	TEST CON	IDITIONS	T _A †	MIN	TYP [‡]	MAX	MIN	TYP [‡]	MAX	UNIT
VIO	Input offset voltage	R _S = 50 Ω		25°C		60	300		200	800	μV
VIO	input onset voltage	KS = 50 22		Full range			550			1000	μν
$\alpha_{V_{IO}}$	Temperature coeficient of input offset voltage			Full range		0.4	2.5		0.7	5	μV/°C
	Long-term drift of input offset voltage			25°C		0.5			0.5		μV/mo
110	Input offset current			25°C		0.15	1.5		0.15	1.5	nA
10	input onset current			Full range			2.8			2.8	ПА
I _{IB}	Input bias current					-12	-30		-12	-30	nA
'ID	Input bido darront			Full range			-38			-38	117.
VICR	Common-mode input voltage range			25°C	-15 to 13.5	-15.3 to 13.8		–15 to 13.5	-15.3 to 13.8		V
	input voitage range				-15 to 13			-15 to 13			
V _{OM}	Maximum peak	$R_1 = 2 k\Omega$		25°C	±12.5	±14		±12.5	±14		V
VOIVI	output voltage swing	11 - 2 132		Full range	±12			±12			v
	Large-signal differential	$V_0 = \pm 10 \text{ V},$	$R_L = 600 \Omega$	25°C	0.5	2		0.5	2		
AVD	voltage amplification	V _O = ±10 V,	$R_1 = 2 k\Omega$	25°C	1.2	8		1.2	8		V/µV
		v0 = =10 v,		Full range	0.7			0.7			
CMRR	Common-mode	V _{IC} = -15 V to	13.5 V	25°C	97	117		97	117		dB
	rejection ratio	10 10 10		Full range	94			94			
	Supply-voltage	101/1	- 140.1/	25°C	100	117		100	117		-ID
ksvr	rejection ratio $(\Delta V_{CC}/\Delta V_{IO})$	$V_{CC\pm} = \pm 2 \text{ V to}$	0 ±18 V	Full range	97			97			dB
	Channel separation	$V_0 = \pm 10 \text{ V},$	R _L = 2 kΩ	25°C	120	137		120	137		dB
rid	Differential input resistance			25°C	70	300		70	300		МΩ
r _{ic}	Common-mode input resistance			25°C		4			4		GΩ
lcc	Supply current			25°C		0.35	0.55		0.35	0.55	mA
	per amplifier			Full range			0.6			0.6	1117 (

[†] Full range is –40°C to 105°C. ‡ All typical values are at T_A = 25°C.

LT1014, LT1014A, LT1014D QUAD PRECISION OPERATIONAL AMPLIFIERS

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electrical characteristics at specified free-air temperature, V_{CC+} = 5 V, V_{CC-} = 0, V_O = 1.4 V, V_{IC} = 0 (unless otherwise noted)

	PARAMETER	TEST COMPLETIONS			LT1014I		L	.T1014DI		
	PARAMETER	TEST CONDITIONS	T _A †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
\/.a	Input offset voltage	Po - 50 O	25°C		90	450		250	950	\/
VIO	input onset voltage	$R_S = 50 \Omega$	Full range			570			1200	μV
lio	Input offset current		25°C		0.2	2		0.2	2	nA
110	input onset current		Full range			6			6	ПА
I _{IB}	Input bias current		25°C		-15	-50		-15	-50	nA
,IR	input bias current		Full range			-90			-90	11/3
VICR	Common-mode		25°C	0 to 3.5	-0.3 to 3.8		0 to 3.5	-0.3 to 3.8		V
1 TICK	input voltage range		Full range	0 to 3			0 to 3			·
		Output low, No load	25°C		15	25		15	25	
		Output low,	25°C		5	10		5	10	mV
		$R_L = 600 \Omega$ to GND	Full range			13			13	IIIV
Vом	Maximum peak output voltage swing	Output low, I _{sink} = 1 mA	25°C		220	350		220	350	
	output voltage owing	Output high, No load	25°C	4	4.4		4	4.4		
		Output high,	25°C	3.4	4		3.4	4		V
		$R_L = 600 \Omega$ to GND	Full range	3.2			3.2			
A _{VD}	Large-signal differential voltage amplification	$V_O = 5$ mV to 4 V, $R_L = 500 \Omega$	25°C		1			1		V/μV
loo	Supply current		25°C		0.3	0.5		0.3	0.5	mA
Icc	per amplifier		Full range			0.55			0.55	IIIA

[†] Full range is –40°C to 105°C.

operating characteristics, $V_{CC}+$ = ± 15 V, V_{IC} = 0, T_A = $25^{\circ}C$

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Slew rate		0.2	0.4		V/μs
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Equivalent input noise voltage	f = 10 Hz		24		nV/√ Hz
V _n	Equivalent input noise voltage	f = 1 kHz	22			nv/√HZ
V _{N(PP)}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 10 Hz		0.55		μV
In	Equivalent input noise current	f = 10 Hz		0.07		pA/√Hz

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electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ± 15 V, V_{IC} = 0 (unless otherwise noted)

D/	NDAMETED	TEST	- +	L	T1014M		Lī	T1014AN	1	Lī	Γ1014DN	1	UNIT
P#	ARAMETER	CONDITIONS	T _A †	MIN	TYP‡	MAX	MIN	TYP [‡]	MAX	MIN	TYP [‡]	MAX	UNII
V _{IO}	Input offset	R _S = 50 Ω	25°C		60	300		60	180		200	800	μV
V10	voltage	115 = 30 22	Full range			550			350			1000	μν
$\alpha_{ m V}$ IO	Temperature coefficient of input offset voltage		Full range		0.5	2.5		0.5	2		0.5	2.5	μV/°C
	Long-term drift of input offset voltage		25°C		0.5			0.5			0.5		μV/mo
lio	Input offset		25°C		0.15	1.5		0.15	8.0		0.15	1.5	nA
10	current		Full range			5			2.8			5	ША
I _{IB}	Input bias		25°C		-12	-30		-12	-20		-12	-30	nA
,ID	current		Full range			-45			-30			-45	
VICR	Common-mode input voltage		25°C	-15 to 13.5	-15.3 to 13.8		-15 to 13.5	-15.3 to 13.8		-15 to 13.5	-15.3 to 13.8		V
	range		Full range	-14.9 to 13			-14.9 to 13			-14.9 to 13			
.,	Maximum peak		25°C	±12.5	±14		±13	±14		±12.5	±14		.,
VOM	output voltage swing	$R_L = 2 k\Omega$	Full range	±11.5			±12			±11.5			٧
•	Large-signal differential	$V_O = \pm 10 \text{ V},$ $R_L = 600 \Omega$	25°C	0.5	2		0.8	2.2		0.5	2		.,,,,,
A_{VD}	voltage	$V_0 = \pm 10 \text{ V},$	25°C	1.2	8		1.5	8		1.2	8		V/μV
	amplification	$R_L = 2 k\Omega$	Full range	0.25			0.4			0.25			
CMRR	Common-mode	V _{IC} = -15 V to 13.5 V	25°C	97	117		100	117		97	117		dB
CIVIKK	rejection ratio	V _{IC} = -14.9 V to 13 V	Full range	94			96			94			uБ
	Supply-voltage	$V_{CC\pm} = \pm 2 \text{ V to}$	25°C	100	117		103	117		100	117		
ksvr	rejection ratio $(\Delta V_{CC}/\Delta V_{IO})$	±18 V	Full range	97			100			97			dB
	Channel separation	$V_O = \pm 10 \text{ V},$ $R_L = 2 \text{ k}\Omega$	25°C	120	137		123	137		120	137		dB
r _{id}	Differential input resistance		25°C	70	300		100	300		70	300		МΩ
r _{ic}	Common-mode input resistance		25°C		4			4			4		GΩ
loc	Supply current		25°C		0.35	0.55		0.35	0.50		0.35	0.55	mA
ICC	per amplifier		Full range			0.7			0.6			0.7	IIIA



[†] Full range is –55°C to 125°C. ‡ All typical values are at T_A = 25°C.

LT1014, LT1014A, LT1014D QUAD PRECISION OPERATIONAL AMPLIFIERS

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electrical characteristics at specified free-air temperature, V_{CC+} = 5 V, V_{CC-} = 0, V_O = 1.4 V, V_{IC} = 0 (unless otherwise noted)

DA.	RAMETER	TEST	- +	L	.T1014M		Lī	Γ1014AN	/	Lī	Γ1014DN	1	UNIT
PA	KAWETER	CONDITIONS	T _A †	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNII
		$R_S = 50\Omega$	25°C		90	450		90	280		250	950	
VIO	Input	118 = 3022	Full range		400	1500		400	960		800	2000	μV
10	offset voltage	$R_S = 50\Omega,$ $V_{IC} = 0.1 \text{ V}$	125°C		200	750		200	480		560	1200	μν
IIO	Input		25°C		0.2	2		0.2	1.3		0.2	2	
10	offset current		Full range			10			7			10	nA
lin	Input		25°C		-15	-50		-15	-35		-15	-50	11/4
ΙΒ	bias current		Full range			-120			-90			-120	
Vion	Common- mode input		25°C	0 to 3.5	-0.3 to 3.8		0 to 3.5	-0.3 to 3.8		0 to 3.5	-0.3 to 3.8		V
VICR	voltage range		Full range	0.1 to 3			0.1 to 3			0.1 to 3			V
		Output low, No load	25°C		15	25		15	25		15	25	
		Output low,	25°C		5	10		5	10		5	10	
		$R_L = 600\Omega$ to GND	Full range			18			15			18	mV
Vом	Maximum peak output voltage swing	Output low, I _{sink} = 1 mA	25°C		220	350		220	350		220	350	
	voltage swing	Output high, No load	25°C	4	4.4		4	4.4		4	4.4		
		Output high,	25°C	3.4	4		3.4	4		3.4	4		V
		$R_L = 600\Omega$ to GND	Full range	3.1			3.2			3.1			
AVD	Large-signal differential voltage amplification	$V_O = 5 \text{ mV to 4 V},$ $R_L = 500\Omega$	25°C		1			1			1		V/μV
Icc	Supply current		25°C		0.3	0.5		0.3	0.45		0.3	0.5	mA
Ļ	per amplifier		Full range			0.65			0.55			0.65	111/1

[†] Full range is –55°C to 125°C.

operating characteristics, $V_{CC\pm}$ = ± 15 V, V_{IC} = 0, T_A = $25^{\circ}C$

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Slew rate		0.2	0.4		V/μs
V	Equivalent input noise voltage	f = 10 Hz		24		->44/11=
V _n	Equivalent input noise voltage	f = 1 kHz		22		nV/√Hz
V _{N(PP)}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 10 Hz		0.55		μV
In	Equivalent input noise current	f = 10 Hz		0.07		pA/√Hz

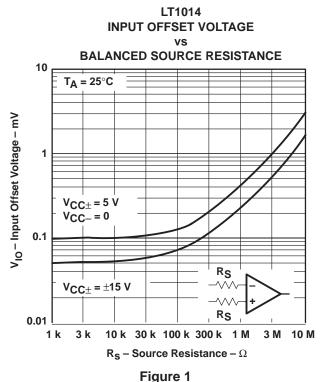


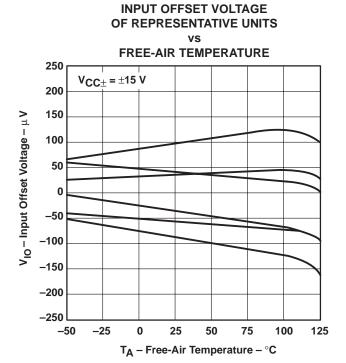
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TYPICAL CHARACTERISTICS

Table of Graphs

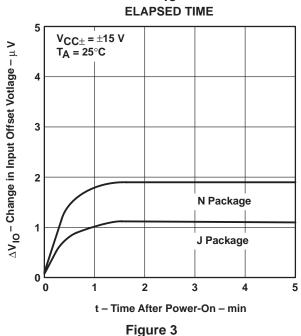
			FIGURE				
VIO	Input offset voltage vs Balanced sou	1					
VIO	Input offset voltage vs Free-air temp	perature	2				
ΔV_{IO}	Warm-Up Change in input offset vol	tage vs Elapsed time	3				
lιο	Input offset current vs Free-air temp	erature	4				
I _{IB}	Input bias current vs Free-air tempe	rature	5				
VIC	Common-mode input voltage vs Inp	ut bias current	6				
Λ. σ	Differential voltage amplification	vs Load resistance	7, 8				
AVD	Differential voltage amplification	vs Frequency	9, 10				
	Channel separation vs Frequency						
	Output saturation voltage vs Free-ai	12					
CMRR	Common-mode rejection ratio vs Fro	13					
ksvr	Supply-voltage rejection ratio vs Fre	14					
Icc	Supply current vs Free-air temperat	15					
los	Short-circuit output current vs Elaps	16					
Vn	Equivalent input noise voltage vs Fr	17					
In	Equivalent input noise current vs Fro	17					
V _{N(PP)}	Peak-to-peak input noise voltage vs	18					
	Pulse response (small signal) vs Tir	19, 21					
	Pulse response (large signal) vs Tin	20, 22, 23					
	Phase shift vs Frequency						





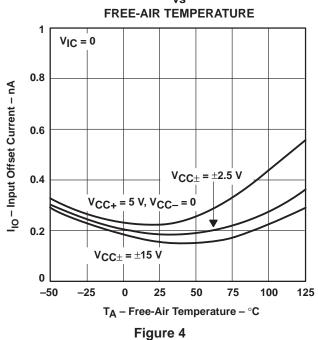
guie i





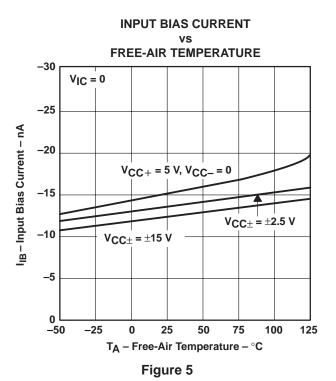
INPUT OFFSET CURRENT vs

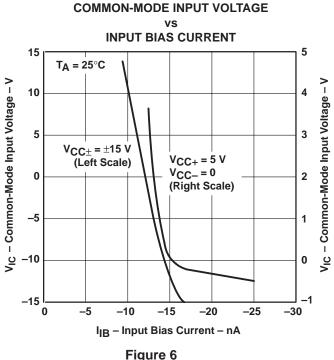
Figure 2

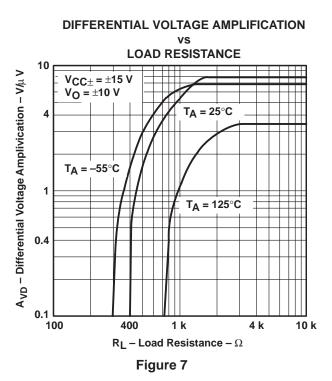


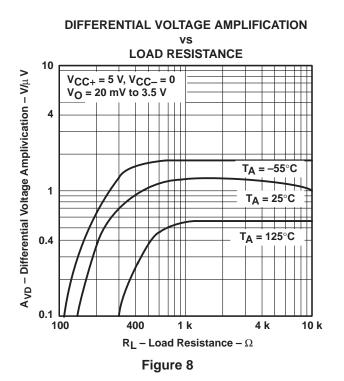
[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.





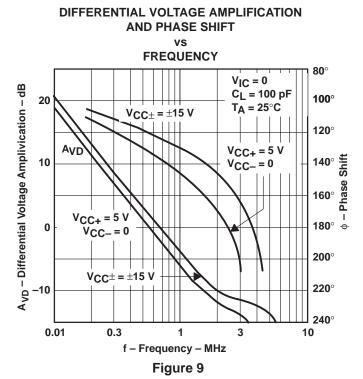


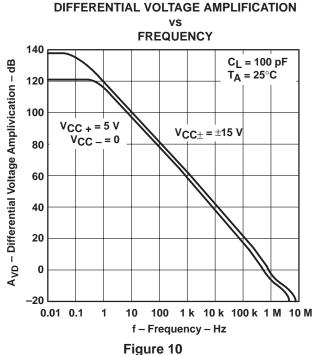


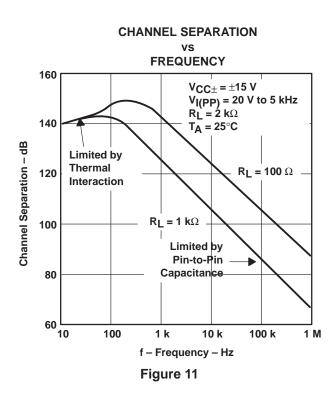


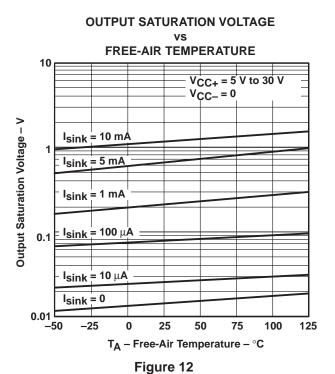
† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.





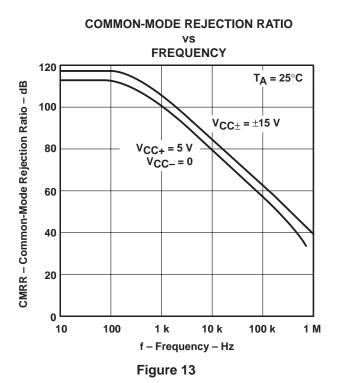






[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.





SUPPLY-VOLTAGE REJECTION RATIO vs

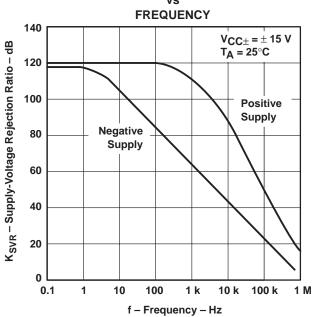
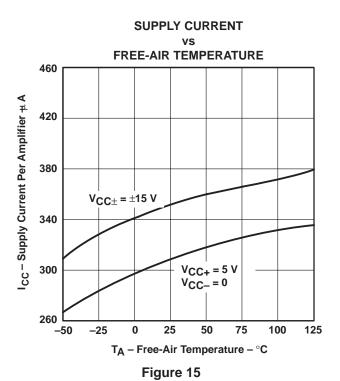
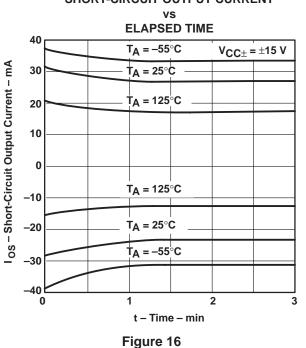


Figure 14



SHORT-CIRCUIT OUTPUT CURRENT



† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.



TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE AND EQUIVALENT INPUT NOISE CURRENT

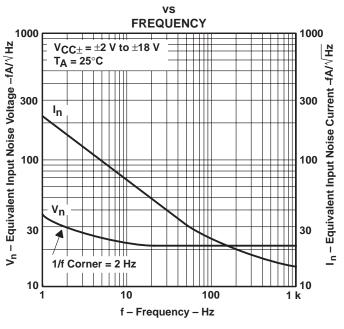


Figure 17

PEAK-TO-PEAK INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD

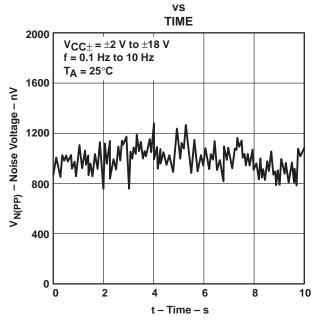


Figure 18

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

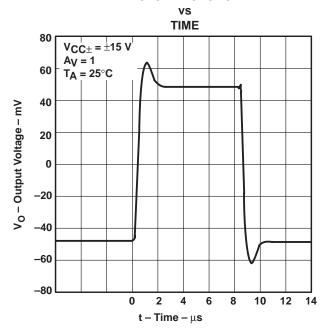


Figure 19

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

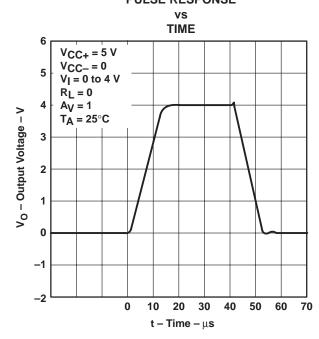
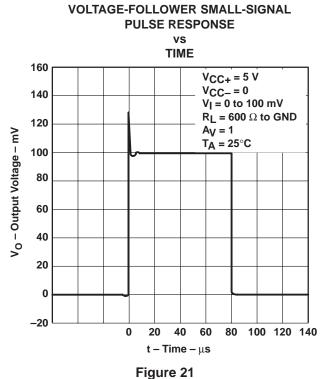


Figure 20

VOLTAGE-FOLLOWER LARGE-SIGNAL

TYPICAL CHARACTERISTICS



PULSE RESPONSE vs TIME 6 V_{CC+} = 5 V $VCC^- = 0$ 5 $V_I = 0$ to 4 V $R_L = 4.7 \text{ k}\Omega \text{ to 5 V}$ 4 $A_V = 1$ V_O - Output Voltage - mV $T_A = 25^{\circ}C$ 3 2 0 -1 50 0 10 20 30 40 60 70

 $t - Time - \mu s$

Figure 22

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

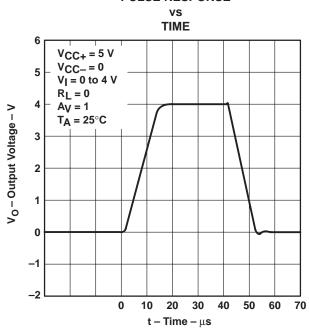


Figure 23

single-supply operation

The LT1014 is fully specified for single-supply operation ($V_{CC-} = 0$). The common-mode input voltage range includes ground, and the output swings within a few millivolts of ground.

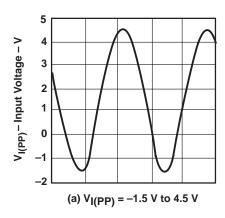
Furthermore, the LT1014 has specific circuitry that addresses the difficulties of single-supply operation, both at the input and at the output. At the input, the driving signal can fall below 0 V, either inadvertently or on a transient basis. If the input is more than a few hundred millivolts below ground, the LT1014 is designed to deal with the following two problems that can occur:

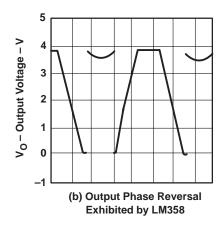
- On many other operational amplifiers, when the input is more than a diode drop below ground, unlimited current flows from the substrate (V_{CC} terminal) to the input, which can destroy the unit. On the LT1014, the 400-Ω resistors in series with the input (see schematic) protect the device even when the input is 5 V below ground.
- 2. When the input is more than 400 mV below ground (at $T_A = 25^{\circ}$ C), the input stage of similar type operational amplifiers saturates, and phase reversal occurs at the output. This can cause lockup in servo systems. Because of unique phase-reversal protection circuitry (Q21, Q22, Q27, and Q28), the LT1014 outputs do not reverse, even when the inputs are at -1.5 V (see Figure 24).

However, this phase-reversal protection circuitry does not function when the other operational amplifier on the LT1014 is driven hard into negative saturation at the output. Phase-reversal protection does not work on an amplifier:

- When 4's output is in negative saturation (the outputs of 2 and 3 have no effect)
- When 3's output is in negative saturation (the outputs of 1 and 4 have no effect)
- When 2's output is in negative saturation (the outputs of 1 and 4 have no effect)
- When 1's output is in negative saturation (the outputs of 2 and 3 have no effect)

At the output, other single-supply designs either cannot swing to within 600 mV of ground or cannot sink more than a few microproamperes while swinging to ground. The all-npn output stage of the LT1014 maintains its low output resistance and high gain characteristics until the output is saturated. In dual-supply operations, the output stage is free of crossover distortion.





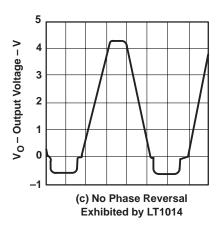
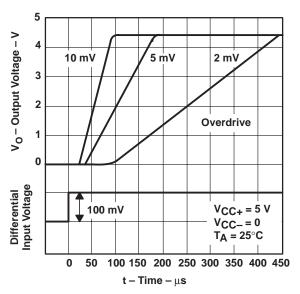


Figure 24. Voltage-Follower Response
With Input Exceeding the Negative Common-Mode Input Voltage Range



comparator applications

The single-supply operation of the LT1014 can be used as a precision comparator with TTL-compatible output. In systems using both operational amplifiers and comparators, the LT1014 can perform multiple duties (see Figures 25 and 26).



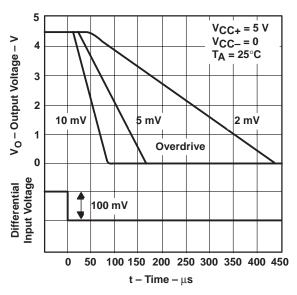


Figure 25. Low-to-High-Level Output Response for Various Input Overdrives

Figure 26. High-to-Low-Level Output Response for Various Input Overdrives

low-supply operation

The minimum supply voltage for proper operation of the LT1014 is 3.4 V (three Ni-Cad batteries). Typical supply current at this voltage is $290 \mu\text{A}$; therefore, power dissipation is only 1 mW per amplifier.

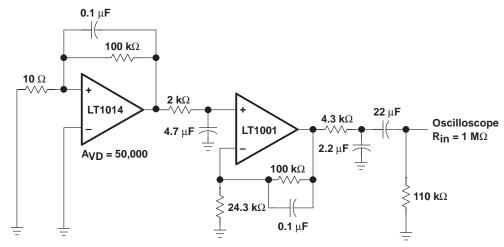
offset voltage and noise testing

Figure 30 shows the test circuit for measuring input offset voltage and its temperature coefficient. This circuit with supply voltages increased to ± 20 V is also used as the burn-in configuration.

The peak-to-peak equivalent input noise voltage of the LT1014 is measured using the test circuit shown in Figure 27. The frequency response of the noise tester indicates that the 0.1-Hz corner is defined by only one zero. The test time to measure 0.1-Hz to 10-Hz noise should not exceed 10 seconds, as this time limit acts as an additional zero to eliminate noise contribution from the frequency band below 0.1 Hz.

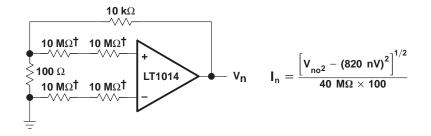
An input noise-voltage test is recommended when measuring the noise of a large number of units. A 10-Hz input noise-voltage measurement correlates well with a 0.1-Hz peak-to-peak noise reading because both results are determined by the white noise and the location of the 1/f corner frequency.

Noise current is measured by the circuit and formula shown in Figure 28. The noise of the source resistors is subtracted.



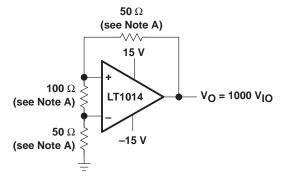
NOTE A: All capacitor values are for nonpolarized capacitors only.

Figure 27. 0.1-Hz to 10-Hz Peak-to-Peak Noise Test Circuit



† Metal-film resistor

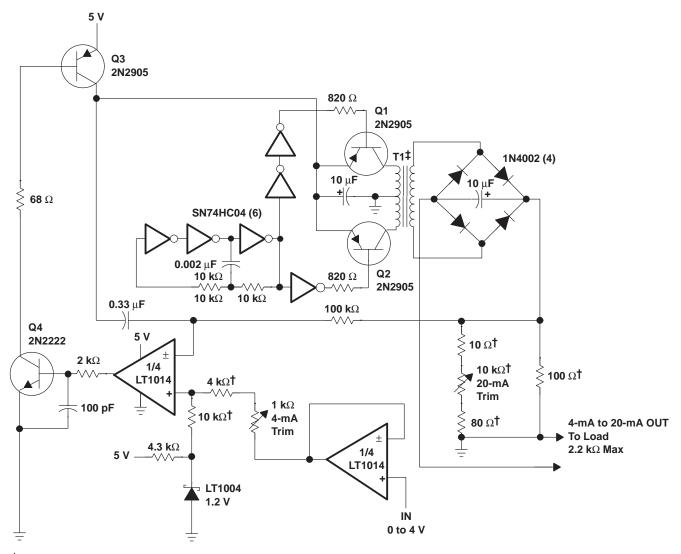
Figure 28. Noise-Current Test Circuit and Formula



NOTE A: Resistors must have low thermoelectric potential.

Figure 29. Test Circuit for V_{IO} and αV_{IO}





† 1% film resistor. Match 10-k Ω resistors 0.05%.

Figure 30. 5-V Powered, 4-mA to 20-mA Current-Loop Transmitter With 12-Bit Accuracy

[‡]T1 = PICO-31080

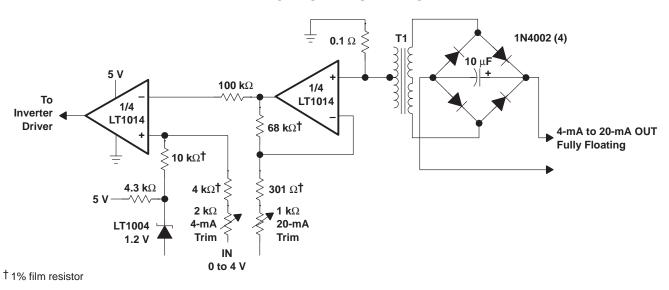
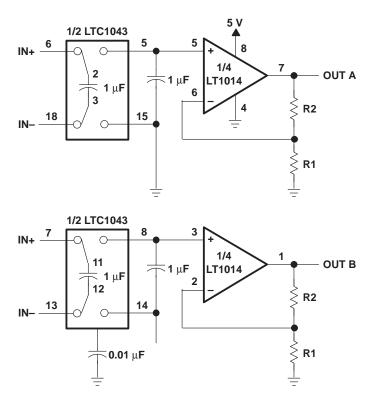


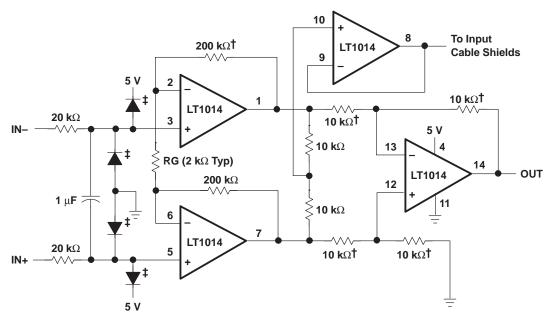
Figure 31. Fully Floating Modification to 4-mA to 20-mA Current-Loop Transmitter With 8-Bit Accuracy



NOTE A: V_{IO} = 150 μ V, A_{VD} = (R1/R2) + 1, CMRR = 120 dB, V_{ICR} = 0 to 5 V

Figure 32. 5-V Single-Supply Dual Instrumentation Amplifier





^{†† 1%} film resistor. Match 10-k Ω resistors 0.05%.

NOTE A: $A_{VD} = (400,000/RG) + 1$

Figure 33. 5-V Powered Precision Instrumentation Amplifier

[‡] For high source impedances, use 2N2222 as diodes (with collector connected to base).





10-Jul-2007

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	e Eco Plan ⁽²⁾	Lead/Ball Finish	n MSL Peak Temp ⁽³⁾
5962-89677012A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-8967701CA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
5962-89677022A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-8967702CA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
LT1014AMFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
LT1014AMJ	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
LT1014AMJB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
LT1014CN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
LT1014CNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
LT1014DDW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DDWE4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DDWG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DDWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DDWRE4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DDWRG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DIDW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DIDWG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DIDWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LT1014DIN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
LT1014DINE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
LT1014DMDW	ACTIVE	SOIC	DW	16	40	TBD	CU NIPDAU	Level-1-220C-UNLIM
LT1014DN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
LT1014DNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
LT1014IN	OBSOLETE	PDIP	N	14		TBD	Call TI	Call TI
LT1014MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
LT1014MJ	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
LT1014MJB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.



PACKAGE OPTION ADDENDUM

10-Jul-2007

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

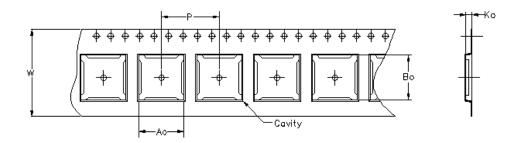
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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Carrier tape design is defined largely by the component lentgh, width, and thickness.

Ao =	Dimension	designed	to	accommodate	the	component	width.
Bo =	Dímension	designed	to	accommodate	the	component	length.
Ko =	Dímension	designed	to	accommodate	the	component	thickness.
W = Overall width of the carrier tape.							
P = Pitch between successive cavity centers.							

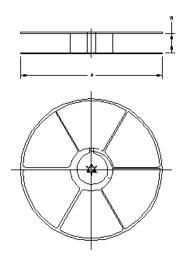


TAPE AND REEL INFORMATION



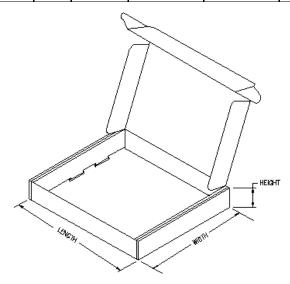
10-Jul-2007

Device	Package	Pins	Site	Reel Diameter (mm)	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LT1014DDWR	DW	16	TAI	330	16	10.75	10.7	2.7	12	16	Q1
LT1014DIDWR	DW	16	TAI	330	16	10.75	10.7	2.7	12	16	Q1



TAPE AND REEL BOX INFORMATION

Device	Package	Pins	Site	Length (mm)	Width (mm)	Height (mm)
LT1014DDWR	DW	16	TAI	346.0	346.0	33.0
LT1014DIDWR	DW	16	TAI	346.0	346.0	33.0



14 LEADS SHOWN



NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. This package is hermetically sealed with a ceramic lid using glass frit.
- D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
- E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

FK (S-CQCC-N**)

28 TERMINAL SHOWN

LEADLESS CERAMIC CHIP CARRIER



NOTES: A. All linear dimensions are in inches (millimeters).

- B. This drawing is subject to change without notice.
- C. This package can be hermetically sealed with a metal lid.
- D. The terminals are gold plated.
- E. Falls within JEDEC MS-004



N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
- The 20 pin end lead shoulder width is a vendor option, either half or full width.



DW (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
- D. Falls within JEDEC MS-013 variation AA.



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