



## LV324

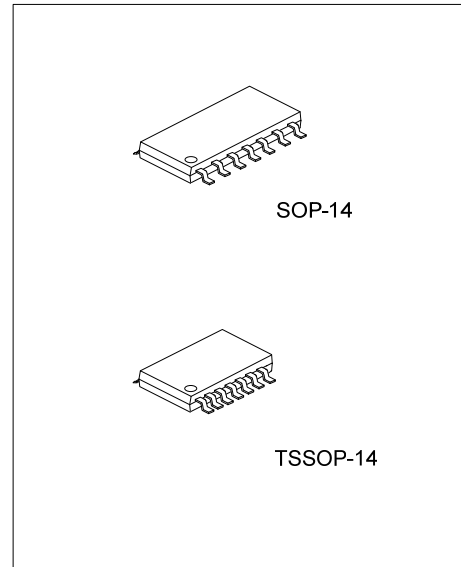
## LINEAR INTEGRATED CIRCUIT

### GENERAL PURPOSE, LOW VOLTAGE, RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

#### DESCRIPTION

The UTC **LV324** is a quad op amp with low supply current and low voltage (2.7~5.5V). It brings nice performance to low voltage and low power systems. With a 1MHz unity-gain frequency. The UTC **LV324** has a guaranteed 1V// $\mu$ s slew rate and low supply current. It provides heavy rail-to-rail (R-to-R) output swing loads and the input common-mode voltage range including ground. Besides, it is also capable for comfortably driving large capacitive loads.

The UTC **LV324** has bipolar input and CMOS output for improved noise performance and higher output current drive. It's the most cost effective solution for the applications where low voltage operation, space saving and low price are required.



#### FEATURES

- \* 4-Channels Op amps
- \* Rail-to-Rail Output Swing
- \* Widely Input Common-Mode Voltage Range
- \* Low Voltage Operation
- \* Low Supply Current: Typ.=410 $\mu$ A @  $V^+ = 5V, V^- = 0V$

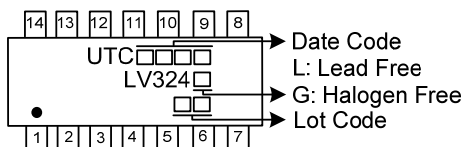
- \* Perfect AC characteristics:
- GBW: Typ.=1MHz
- SR: Typ.=1V/ $\mu$ s
- $\phi_m$ : Typ.=60Deg
- $G_m$ : Typ.=10dB.

#### ORDERING INFORMATION

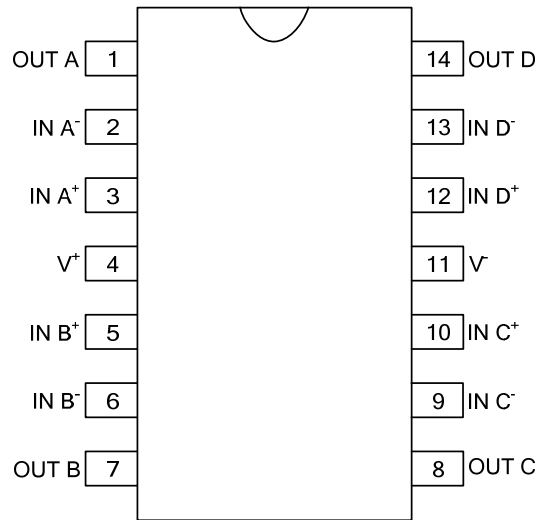
Ordering Number		Package	Packing
Lead Free	Halogen Free		
LV324L-S14-R	LV324G-S14-R	SOP-14	Tape Reel
LV324L-P14-R	LV324G-P14-R	TSSOP-14	Tape Reel

<p>LV324G-S14-R</p> <ul style="list-style-type: none"> <li>(1)Packing Type</li> <li>(2)Package Type</li> <li>(3)Green Package</li> </ul>	<ul style="list-style-type: none"> <li>(1) R: Tape Reel</li> <li>(2) S14: SOP-14, P14: TSSOP-14</li> <li>(3) G: Halogen Free and Lead Free, L: Lead Free</li> </ul>
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#### MARKING



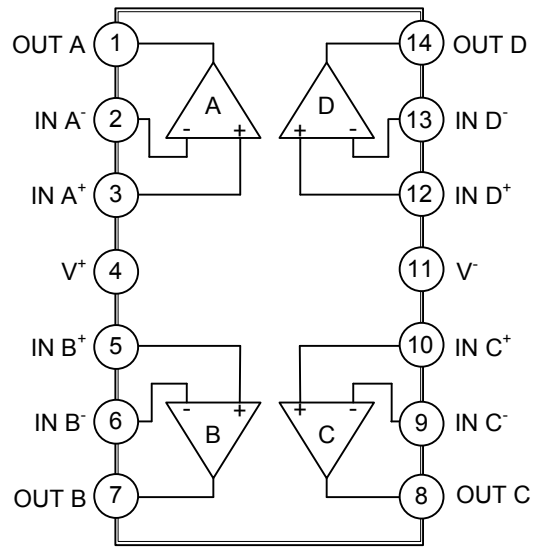
### ■ PIN CONFIGURATION



### ■ PIN DESCRIPTION

PIN NO.	PIN NAME	FUNCTION
1	OUT A	Output of channel A
2	IN A <sup>-</sup>	Inverting Input of Channel A
3	IN A <sup>+</sup>	Non-Inverting Input of Channel A
4	V <sup>+</sup>	Positive of Supply Voltage
5	IN B <sup>+</sup>	Non-Inverting Input of Channel B
6	IN B <sup>-</sup>	Inverting Input of Channel B
7	OUT B	Output of channel B
8	OUT C	Output of channel C
9	IN C <sup>-</sup>	Inverting Input of Channel C
10	IN C <sup>+</sup>	Non-Inverting Input of Channel C
11	V <sup>-</sup>	Negative of Supply Voltage
12	IN D <sup>+</sup>	Non-Inverting Input of Channel D
13	IN D <sup>-</sup>	Inverting Input of Channel D
14	OUT D	Output of channel D

■ BLOCK DIAGRAM



### ■ ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	RATINGS	UNIT
Differential Input Voltage	$V_{IDM}$	$\pm$ Supply Voltage	V
Supply Voltage ( $V^+ - V^-$ )	$V^+ - V^-$	5.5	V
Output Short Current to $V^+$	$I_{O(SC)}$	Note 1	A
Output Short Current to $V^-$	$I_{O(SC)}$	Note 2	A
Infrared or Convection (20sec)		235	$^{\circ}$ C
<b>Operating Ratings</b>			
Supply Voltage	$V^+ - V^-$	2.7 ~ 5.5	V
Temperature Range	$T_A$	-40 ~ +85	$^{\circ}$ C
Junction Temperature	$T_J$	+150	$^{\circ}$ C
Storage Temperature Range	$T_{STG}$	-65 ~ +150	$^{\circ}$ C

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

2. Shorting output to  $V^+$  will adversely affect reliability.

3. Shorting output to  $V^-$  will adversely affect reliability.

### ■ THERMAL DATA

PARAMETER	SYMBOL	RATINGS	UNIT
Thermal Resistance (Note)	SOP-14	145	$^{\circ}$ C/W
	TSSOP-14	155	$^{\circ}$ C/W

Note: All numbers are typical, and apply for packages soldered directly onto a PC board in still air.

### ■ 2.7V ELECTRICAL CHARACTERISTICS

All limits guaranteed for  $T_J = 25^{\circ}$ C,  $V^+ = 2.7$ V,  $V^- = 0$ V,  $V_{CM} = 1.0$ V,  $V_{OUT} = V^+ / 2$  and  $R_L > 1$ M $\Omega$ , unless otherwise specified.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN (Note 6)	TYP (Note 5)	MAX (Note 6)	UNIT
<b>DC CHARACTERISTICS</b>						
Input Offset Voltage	$V_{OS}$			1.7	7	mV
Input Offset Voltage Average Drift	$TCV_{OS}$			5		$\mu$ V/ $^{\circ}$ C
Input Bias Current	$I_B$			11	250	nA
Input Offset Current	$I_{OS}$			5	50	nA
Common Mode Rejection Ratio	CMRR	$0V \leq V_{CM} \leq 1.7V$	50	63		dB
Power Supply Rejection Ratio	PSRR	$2.7V \leq V^+ \leq 5V, V_O = 1V$	50	60		dB
Input Common-Mode Voltage Range	$V_{CM}$	For CMRR $\geq 50$ dB	0	-0.2		V
				1.9	1.7	V
Output Swing	$V_{OUT}$	$R_L = 10k\Omega$ to 1.35V	$V^+ - 100$	$V^+ - 10$		mV
				60	180	mV
Supply Current	$I_S$	All four amplifiers		260	680	$\mu$ A
<b>AC CHARACTERISTICS</b>						
Gain-Bandwidth Product	GBWP	$C_L = 200$ pF		1		MHZ
Phase Margin	$\phi_m$			60		Deg
Gain Margin	Gm			10		dB
Input-Referred Voltage Noise	$e_n$	f=1kHz		46		nV/ $\sqrt$ HZ
Input-Referred Current Noise	$i_n$	f=1kHz		0.17		pA/ $\sqrt$ HZ

### ■ 5V ELECTRICAL CHARACTERISTICS (Cont.)

All limits guaranteed for  $T_J=25^\circ\text{C}$ ,  $V^+=5\text{V}$ ,  $V^-=0\text{V}$ ,  $V_{CM}=2.0\text{V}$ ,  $V_O=V^+/2$  and  $R_L>1\text{M}\Omega$ , unless otherwise specified. Boldface limits apply at the temperature extremes.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN (Note 6)	TYP (Note 5)	MAX (Note 6)	UNIT
<b>DC CHARACTERISTICS</b>						
Input Offset Voltage	$V_{OS}$			1.7	7	mV
					<b>9</b>	mV
Input Offset Voltage Average Drift	$TCV_{OS}$			5		$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_B$			11	250	nA
					<b>500</b>	nA
Input Offset Current	$I_{OS}$			5	50	nA
					<b>150</b>	nA
Common Mode Rejection Ratio	CMRR	$0\text{V}\leq V_{CM}\leq 4\text{V}$	50	65		dB
Power Supply Rejection Ratio	PSRR	$2.7\text{V}\leq V^+\leq 5\text{V}$ , $V_O=1\text{V}$ , $V_{CM}=1\text{V}$	50	60		dB
Input Common-Mode Voltage Range	$V_{CM}$	For CMRR $\geq$ 50dB	0	-0.2		V
				4.2	4	V
Large Signal Voltage Gain (Note 7)	$A_v$		15	100		V/mV
			<b>10</b>			V/mV
Output Swing	$V_O$	$R_L=2\text{k}\Omega$ to 2.5V	$V^+-300$	$V^+-40$		mV
			<b><math>V^+-400</math></b>			mV
				120	300	mV
		$R_L=10\text{k}\Omega$ to 2.5V			<b>400</b>	mV
			$V^+-100$	$V^+-10$		mV
			<b><math>V^+-200</math></b>			mV
Output Short Circuit Current	$I_O$	Sourcing, $V_O=0\text{V}$	5	60		mA
		Sourcing, $V_O=5\text{V}$	10	160		mA
Supply Current	$I_S$	All four amplifiers		410	830	$\mu\text{A}$
					<b>1160</b>	$\mu\text{A}$
<b>AC CHARACTERISTICS</b>						
Slew Rate	SR	(Note 8)		1		V/ $\mu\text{s}$
Gain-Bandwidth Product	GBWP	$C_L=200\text{pF}$		1		MHz
Phase Margin	$\phi_m$			60		Deg
Gain Margin	$G_m$			10		dB
Input-Referred Voltage Noise	$e_n$	$f=1\text{kHz}$		39		$\text{nV}/\sqrt{\text{Hz}}$
Input-Referred Current Noise	$i_n$	$f=1\text{kHz}$		0.21		$\text{pA}/\sqrt{\text{Hz}}$

Notes: 4. The maximum power dissipation is a function of  $T_{J(\text{MAX})}$ ,  $\theta_{JA}$ . The maximum allowable power dissipation at any ambient temperature is  $P_D=(T_{J(\text{MAX})}-T_A)/\theta_{JA}$ . All numbers apply for packages soldered directly onto a PC Board.

5. Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

6. All limits are guaranteed by testing or statistical analysis.

7.  $R_L$  is connected to  $V^-$ . The output voltage is  $0.5\text{V}\leq V_O\leq 4.5\text{V}$ .

8. Connected as voltage follower with 3V step input. Number specified is the slower of the positive and negative slew rates.

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