

- **2.7-V and 5-V Performance**
- **No Crossover Distortion**
- **Low Supply Current at  $V_{CC+} = 5\text{ V}$ :**  
 TLV821 . . . 0.3 mA Typ  
 TLV822 . . . 0.5 mA Typ  
 TLV824 . . . 1 mA Typ
- **Rail-to-Rail Output Swing**
- **Pin-to-Pin Compatible with LMV821, LMV822, and LMV824 Devices**
- **Package Options Include Plastic Small-Outline (D), Small-Outline Transistor (SOT-23 DBV, SC-70 DCK), and Thin Shrink Small-Outline (PW) Packages**

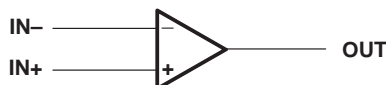
## description

The TLV821, TLV822, and TLV824 devices are low-voltage (2.5 V to 5.5 V) low-power operational amplifiers, designed to be functionally and pin-to-pin compatible with the LMV821, LMV822, and LMV824 devices. Electrical characteristics are very similar to the LMV3xx operational amplifiers (low supply current, rail-to-rail outputs, input common-mode range, which includes ground). The TLV8xx devices have a significantly higher bandwidth (8 MHz typically) and a 2.5-V/ $\mu\text{s}$  slew rate. The TLV821 is a single, the TLV822 is a dual, and the TLV824 is a quad operational amplifier.

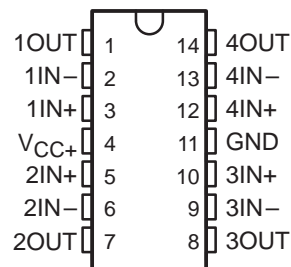
These devices are the most cost-effective solution for applications requiring low-voltage/low-power operation and space-saving considerations. The TLV821 is available in the ultra-small DCK package, which is approximately half the size of the DBV package. The DCK package saves space on PC boards and enables the design of small portable electronic devices (cordless and cellular phones, laptops, PDAs, PCMIAs). It also allows the designer to place the device closer to the signal source to reduce noise pickup and increase signal integrity.

The TLV821I, TLV822I, and TLV824I devices are characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

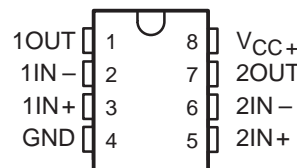
## symbol (each amplifier)



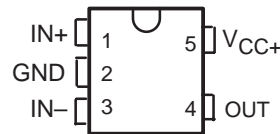
TLV824 . . . D OR PW PACKAGE  
(TOP VIEW)



TLV822 . . . D OR PW PACKAGE  
(TOP VIEW)



TLV821 . . . DBV OR DCK PACKAGE  
(TOP VIEW)



# TLV821 SINGLE/TLV822 DUAL/TLV824 QUAD OPERATIONAL AMPLIFIERS

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## AVAILABLE OPTIONS

T <sub>A</sub>	PACKAGE TYPE	PACKAGED DEVICES		
		SINGLE	DUAL	QUADRUPLE
–40°C to 85°C	5-pin SOT	TLV821IDCKR TLV821IDBVR	— —	— —
	8-pin SOIC	—	TLV822ID	—
	8-pin TSSOP	—	TLV822IPWR	—
	14-pin SOIC	—	—	TLV824ID
	14-pin TSSOP	—	—	TLV824IPWR

The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLV824IDR).  
The DCK, DBV, and PW packages are only available left-end taped and reeled.

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage, V <sub>CC</sub> (see Note 1)	5.5 V
Differential input voltage, V <sub>ID</sub> (see Note 2)	±5.5 V
Input voltage range, V <sub>I</sub> (either input)	0 to 5.5 V
Duration of output short circuit (one amplifier) to ground at (or below) T <sub>A</sub> = 25°C, V <sub>CC</sub> ≤ 5.5 V (see Note 3)	Unlimited
Operating virtual junction temperature	150°C
Package thermal impedance, θ <sub>JA</sub> (see Notes 4 and 5): D (8-pin) package	97°C/W
D (14-pin) package	86°C/W
DBV package	347°C/W
DCK package	389°C/W
PW (8-pin) package	149°C/W
PW (14-pin) package	113°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or PW package	260°C
Storage temperature range, T <sub>stg</sub>	–65 to 150°C

<sup>†</sup> 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 and V<sub>CC</sub> specified for the measurement of I<sub>OS</sub>) are with respect to the network GND.
  2. Differential voltages are at IN+ with respect to IN–.
  3. Short circuits from outputs to V<sub>CC</sub> can cause excessive heating and eventual destruction.
  4. Maximum power dissipation is a function of T<sub>J</sub>(max), θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J</sub>(max) – T<sub>A</sub>)/θ<sub>JA</sub>. Selecting the maximum of 150°C can affect reliability.
  5. The package thermal impedance is calculated in accordance with JESD 51.

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# TLV821 SINGLE/TLV822 DUAL/TLV824 QUAD OPERATIONAL AMPLIFIERS

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## recommended operating conditions

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage (single-supply operation)	2.5	5.5	V
$T_A$	Operating free-air temperature	-40	85	°C

electrical characteristics at specified free-air temperature,  $V_{CC+} = 2.7$  V,  
GND = 0 V,  $V_{CM} = 1$  V,  $V_O = 1.35$  V, and  $R_L > 1$  M $\Omega$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	MIN	TYP	MAX	UNIT	
V <sub>IO</sub>	Input offset voltage			25°C		1	3.5	mV	
				−40°C to 85°C			4		
α <sub>V<sub>IO</sub></sub>	Average temperature coefficient of input offset voltage			25°C		1		μV/°C	
I <sub>IB</sub>	Input bias current			25°C		30	90	nA	
				−40°C to 85°C			140		
I <sub>IO</sub>	Input offset current			25°C		0.5	30	nA	
				−40°C to 85°C			50		
CMRR	Common-mode rejection ratio	V <sub>CM</sub> = 0 to 1.7 V		25°C		60	73	dB	
				−40°C to 85°C		58			
+kSVR	Positive supply-voltage rejection ratio	V <sub>CC+</sub> = 1.7 V to 4 V, GND = 1 V, V <sub>CM</sub> = 0, V <sub>O</sub> = 0		25°C		60	75	dB	
				−40°C to 85°C		58			
−kSVR	Negative supply-voltage rejection ratio	V <sub>CC+</sub> = 1.7 V, GND = −1 V to −3.3 V, V <sub>CM</sub> = 0, V <sub>O</sub> = 0		25°C		60	75	dB	
				−40°C to 85°C		58			
V <sub>ICR</sub>	Common-mode input voltage range	CMRR ≥ 50 dB		25°C		−0.2	−0.3	V	
						1.9	2		
A <sub>VD</sub>	Large-signal differential-voltage amplification	R <sub>L</sub> = 600 Ω to 1.35 V, V <sub>O</sub> = 1.35 V to 2.2 V	Sourcing	25°C		90	100	dB	
				−40°C to 85°C		85			
		R <sub>L</sub> = 600 Ω to 1.35 V, V <sub>O</sub> = 1.35 V to 0.5 V	Sinking	25°C		85	90		
				−40°C to 85°C		80			
		R <sub>L</sub> = 2 kΩ to 1.35 V, V <sub>O</sub> = 1.35 V to 2.2 V	Sourcing	25°C		95	100		
				−40°C to 85°C		90			
		R <sub>L</sub> = 2 kΩ to 1.35 V, V <sub>O</sub> = 1.35 V to 0.5 V	Sinking	25°C		90	95		
				−40°C to 85°C		85			
Output swing		V <sub>CC+</sub> = 2.7 V, R <sub>L</sub> = 600 Ω to 1.35 V	High level	25°C		2.5	2.58	V	
					−40°C to 85°C		2.4		
			Low level	25°C			0.13		0.2
					−40°C to 85°C				0.3
		V <sub>CC+</sub> = 2.7 V, R <sub>L</sub> = 2 kΩ to 1.35 V	High level	25°C		2.6	2.66		
					−40°C to 85°C		2.5		
			Low level	25°C			0.08		0.12
					−40°C to 85°C				0.2

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# TLV821 SINGLE/TLV822 DUAL/TLV824 QUAD OPERATIONAL AMPLIFIERS

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electrical characteristics at specified free-air temperature,  $V_{CC+} = 2.7\text{ V}$ ,  
 $GND = 0\text{ V}$ ,  $V_{CM} = 1\text{ V}$ ,  $V_O = 1.35\text{ V}$ , and  $R_L > 1\text{ M}\Omega$  (unless otherwise noted) (continued)

PARAMETER	TEST CONDITIONS		$T_A$	MIN	TYP	MAX	UNIT
$I_O$ Output current	$V_O = 0\text{ V}$	Sourcing	$25^\circ\text{C}$	12	16		mA
	$V_O = 2.7\text{ V}$	Sinking	$25^\circ\text{C}$	12	26		
$I_{CC}$ Supply current	TLV821I		$25^\circ\text{C}$		0.22	0.3	mA
			$-40^\circ\text{C}$ to $85^\circ\text{C}$			0.5	
	TLV822I (both amplifiers)		$25^\circ\text{C}$		0.45	0.6	
			$-40^\circ\text{C}$ to $85^\circ\text{C}$			0.8	
	TLV824I (all four amplifiers)		$25^\circ\text{C}$		0.72	1	
			$-40^\circ\text{C}$ to $85^\circ\text{C}$			1.2	
SR Slew rate	$V_{CC+} = 5\text{ V}^\dagger$		$25^\circ\text{C}$		2		V/ $\mu\text{s}$
GBM Gain-bandwidth product			$25^\circ\text{C}$		7		MHz
$\phi_m$ Phase margin			$25^\circ\text{C}$		61		deg
$G_m$ Gain margin			$25^\circ\text{C}$		10		dB
Amplifier-to-amplifier isolation	$V_{CC+} = 5\text{ V}$ , $R_L = 100\text{ k}\Omega$ to $2.5\text{ V}^\ddagger$		$25^\circ\text{C}$		135		dB
$V_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$ , $V_{CM} = 1\text{ V}$		$25^\circ\text{C}$		28		nV/ $\sqrt{\text{Hz}}$
$I_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$		$25^\circ\text{C}$		0.1		pA/ $\sqrt{\text{Hz}}$
THD Total harmonic distortion	$f = 1\text{ kHz}$ , $A_{VD} = -2$ , $R_L = 10\text{ k}\Omega$ , $V_O = 4.1\text{ V}_{PP}$		$25^\circ\text{C}$		0.01%		

$^\dagger$  Connected as voltage follower with 3-V step input. Value specified is the slower of the positive and negative slew rates.

$^\ddagger$  Refers to inputs only. Each amplifier is excited, in turn, with 1 kHz to produce  $V_O = 3\text{ V}_{PP}$ .

# TLV821 SINGLE/TLV822 DUAL/TLV824 QUAD OPERATIONAL AMPLIFIERS

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electrical characteristics at specified free-air temperature,  $V_{CC+} = 5\text{ V}$ ,  
 $GND = 0\text{ V}$ ,  $V_{CM} = 2\text{ V}$ ,  $V_O = 2.5\text{ V}$ , and  $R_L > 1\text{ M}\Omega$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS		$T_A$	MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage			25°C		1	3.5	mV
				–40°C to 85°C			4	
$\alpha_{V_{IO}}$	Average temperature coefficient of input offset voltage			25°C		1		$\mu\text{V}/^\circ\text{C}$
$I_{IB}$	Input bias current			25°C		40	100	nA
				–40°C to 85°C			150	
$I_{IO}$	Input offset current			25°C		0.5	30	nA
				–40°C to 85°C			50	
CMRR	Common-mode rejection ratio	$V_{CM} = 0\text{ to }4\text{ V}$		25°C		62	75	dB
				–40°C to 85°C		60		
+kSVR	Positive supply-voltage rejection ratio	$V_{CC+} = 1.7\text{ V to }4\text{ V}$ , $GND = -1\text{ V}$ , $V_{CM} = 0$ , $V_O = 0$		25°C		60	75	dB
				–40°C to 85°C		58		
–kSVR	Negative supply-voltage rejection ratio	$V_{CC+} = 1.7\text{ V}$ , $GND = -1\text{ V to }-3.3\text{ V}$ , $V_{CM} = 0$ , $V_O = 0$		25°C		60	75	dB
				–40°C to 85°C		58		
$V_{ICR}$	Common-mode input voltage range	CMRR $\geq 50\text{ dB}$		25°C	–0.2	–0.3		V
					4.2	4.3		
$A_{VD}$	Large-signal differential-voltage amplification	$R_L = 600\ \Omega\text{ to }2.5\text{ V}$ , $V_O = 2.5\text{ V to }4.5\text{ V}$	Sourcing	25°C		95	105	dB
				–40°C to 85°C		90		
		$R_L = 600\ \Omega\text{ to }2.5\text{ V}$ , $V_O = 2.5\text{ V to }0.5\text{ V}$	Sinking	25°C		95	105	
				–40°C to 85°C		90		
		$R_L = 2\text{ k}\Omega\text{ to }2.5\text{ V}$ , $V_O = 2.5\text{ V to }4.5\text{ V}$	Sourcing	25°C		95	105	
				–40°C to 85°C		90		
		$R_L = 2\text{ k}\Omega\text{ to }2.5\text{ V}$ , $V_O = 2.5\text{ V to }0.5\text{ V}$	Sinking	25°C		95	105	
				–40°C to 85°C		90		
Output swing		$V_{CC+} = 5\text{ V}$ , $R_L = 600\ \Omega\text{ to }2.5\text{ V}$	High level	25°C		4.75	4.84	V
				–40°C to 85°C		4.7		
			Low level	25°C		0.17	0.25	
				–40°C to 85°C			0.3	
		$V_{CC+} = 5\text{ V}$ , $R_L = 2\text{ k}\Omega\text{ to }2.5\text{ V}$	High level	25°C		4.85	4.9	
				–40°C to 85°C		4.8		
			Low level	25°C		0.1	0.15	
				–40°C to 85°C			0.2	
$I_O$	Output current	$V_O = 0\text{ V}$	Sourcing	25°C		20	45	mA
				–40°C to 85°C		15		
		$V_O = 5\text{ V}$	Sinking	25°C		20	40	
				–40°C to 85°C		15		

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# TLV821 SINGLE/TLV822 DUAL/TLV824 QUAD OPERATIONAL AMPLIFIERS

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electrical characteristics at specified free-air temperature,  $V_{CC+} = 5\text{ V}$ ,  $GND = 0\text{ V}$ ,  $V_{CM} = 2\text{ V}$ ,  $V_O = 2.5\text{ V}$ , and  $R_L > 1\text{ M}\Omega$  (unless otherwise noted) (continued)

PARAMETER	TEST CONDITIONS	$T_A$	MIN	TYP	MAX	UNIT
$I_{CC}$ Supply current	TLV821I	25°C		0.3	0.4	mA
		–40°C to 85°C			0.6	
	TLV822I (both amplifiers)	25°C		0.5	0.7	
		–40°C to 85°C			0.9	
	TLV824I (all four amplifiers)	25°C		1	1.3	
		–40°C to 85°C			1.5	
SR Slew rate	$V_{CC+} = 5\text{ V}^\dagger$	25°C	2	2.5		V/ $\mu$ s
GBM Gain-bandwidth product		25°C		8		MHz
$\phi_m$ Phase margin		25°C		67		deg
$G_m$ Gain margin		25°C		15		dB
Amplifier-to-amplifier isolation	$V_{CC+} = 5\text{ V}$ , $R_L = 100\text{ k}\Omega$ to $2.5\text{ V}^\ddagger$	25°C		135		dB
$V_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$ , $V_{CM} = 1\text{ V}$	25°C		24		nV/ $\sqrt{\text{Hz}}$
$I_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$	25°C		0.25		pA/ $\sqrt{\text{Hz}}$
THD Total harmonic distortion	$f = 1\text{ kHz}$ , $A_{VD} = -2$ , $R_L = 10\text{ k}\Omega$ , $V_O = 4.1\text{ V}_{PP}$	25°C		0.01%		

$^\dagger$  Connected as voltage follower with 3-V step input. Value specified is the slower of the positive and negative slew rates.

$^\ddagger$  Refers to inputs only. Each amplifier is excited, in turn, with 1 kHz to produce  $V_O = 3\text{ V}_{PP}$ .

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