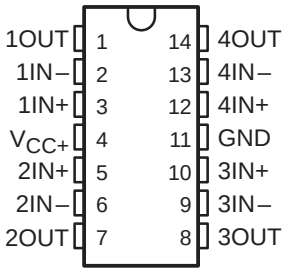
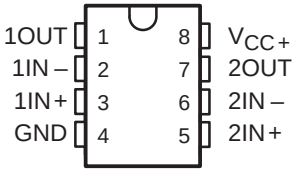
- **2.7-V and 5-V Performance**
- **No Crossover Distortion**
- **Low Supply Current at $V_{CC+}$ = 5 V:**
  - **TLV821 . . . 0.3 mA Typ**
  - **TLV822 . . . 0.5 mA Typ**
  - **TLV824 . . . 1 mA Typ**
- **Rail-to-Rail Output Swing**
- **Pin-to-Pin Compatible with LMV821, LMV822, and LMV824 Devices**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

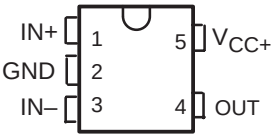
**TLV824 . . . D OR PW PACKAGE**
**(TOP VIEW)**




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




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



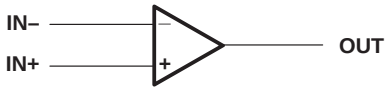

## description

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/μs 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°C to 85°C.

## symbol (each amplifier)




PRODUCT PREVIEW

**AVAILABLE OPTIONS**

| $T_A$ | 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)†

Supply voltage, $V_{CC}$ (see Note 1) . . . . . 5.5 V
Differential input voltage, $V_{ID}$ (see Note 2) . . . . . ±5.5 V
Input voltage range, $V_I$ (either input) . . . . . 0 to 5.5 V
Duration of output short circuit (one amplifier) to ground at (or below) $T_A$ = 25°C, $V_{CC} \le 5.5$ V (see Note 3) . . . . . Unlimited
Operating virtual junction temperature . . . . . 150°C
Package thermal impedance, $\theta_{JA}$ (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, $T_{stg}$ . . . . . –65 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 and $V_{CC}$ specified for the measurement of $I_{OS}$) are with respect to the network GND.
2. Differential voltages are at IN+ with respect to IN–.
3. Short circuits from outputs to $V_{CC}$ can cause excessive heating and eventual destruction.
4. Maximum power dissipation is a function of $T_J(max)$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Selecting the maximum of 150°C can affect reliability.
5. The package thermal impedance is calculated in accordance with JESD 51.

PRODUCT PREVIEW

## 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 MΩ (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 | | μV/°C |
| $I_{IB}$ | Input bias current | | | 25°C | | 30 | 90 | nA |
| | | | | –40°C to 85°C | | | 140 | |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 30 | nA |
| | | | | –40°C to 85°C | | | 50 | |
| CMRR | Common-mode rejection ratio | $V_{CM}$ = 0 to 1.7 V | | 25°C | 60 | 73 | | dB |
| | | | | –40°C to 85°C | 58 | | | |
| $+k_{SVR}$ | Positive supply-voltage rejection ratio | $V_{CC+}$ = 1.7 V to 4 V, GND = 1 V, $V_{CM}$ = 0, $V_O$ = 0 | | 25°C | 60 | 75 | | dB |
| | | | | –40°C to 85°C | 58 | | | |
| $–k_{SVR}$ | Negative supply-voltage rejection ratio | $V_{CC+}$ = 1.7 V, GND = –1 V to –3.3 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 ≥ 50 dB | | 25°C | –0.2 | –0.3 | | V |
| | | | | | 1.9 | 2 | | |
| $A_{VD}$ | Large-signal differential-voltage amplification | $R_L$ = 600 Ω to 1.35 V, $V_O$ = 1.35 V to 2.2 V | Sourcing | 25°C | 90 | 100 | | dB |
| | | | | –40°C to 85°C | 85 | | | |
| | | $R_L$ = 600 Ω to 1.35 V, $V_O$ = 1.35 V to 0.5 V | Sinking | 25°C | 85 | 90 | | |
| | | | | –40°C to 85°C | 80 | | | |
| | | $R_L$ = 2 kΩ to 1.35 V, $V_O$ = 1.35 V to 2.2 V | Sourcing | 25°C | 95 | 100 | | |
| | | | | –40°C to 85°C | 90 | | | |
| | | $R_L$ = 2 kΩ to 1.35 V, $V_O$ = 1.35 V to 0.5 V | Sinking | 25°C | 90 | 95 | | |
| | | | | –40°C to 85°C | 85 | | | |
| | Output swing | $V_{CC+}$ = 2.7 V, $R_L$ = 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 | |
| | | $V_{CC+}$ = 2.7 V, $R_L$ = 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 | |

PRODUCT PREVIEW

## 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 MΩ (unless otherwise noted) (continued)

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

† Connected as voltage follower with 3-V step input. Value specified is the slower of the positive and negative slew rates.
‡ Refers to inputs only. Each amplifier is excited, in turn, with 1 kHz to produce $V_O$ = 3 $V_{PP}$.

PRODUCT PREVIEW

## electrical characteristics at specified free-air temperature, $V_{CC+}$ = 5 V, GND= 0 V, $V_{CM}$ = 2 V, $V_O$ = 2.5 V, and $R_L$ > 1 MΩ (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 | | μV/°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 to 4 V | | 25°C | 62 | 75 | | dB |
| | | | | –40°C to 85°C | 60 | | | |
| $+k_{SVR}$ | Positive supply-voltage rejection ratio | $V_{CC+}$ = 1.7 V to 4 V, GND = –1 V, $V_{CM}$ = 0, $V_O$ = 0 | | 25°C | 60 | 75 | | dB |
| | | | | –40°C to 85°C | 58 | | | |
| $–k_{SVR}$ | Negative supply-voltage rejection ratio | $V_{CC+}$ = 1.7 V, GND = –1 V to –3.3 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 ≥ 50 dB | | 25°C | –0.2 | –0.3 | | V |
| | | | | | 4.2 | 4.3 | | |
| $A_{VD}$ | Large-signal differential-voltage amplification | $R_L$ = 600 Ω to 2.5 V, $V_O$ = 2.5 V to 4.5 V | Sourcing | 25°C | 95 | 105 | | dB |
| | | | | –40°C to 85°C | 90 | | | |
| | | $R_L$ = 600 Ω to 2.5 V, $V_O$ = 2.5 V to 0.5 V | Sinking | 25°C | 95 | 105 | | |
| | | | | –40°C to 85°C | 90 | | | |
| | | $R_L$ = 2 kΩ to 2.5 V, $V_O$ = 2.5 V to 4.5 V | Sourcing | 25°C | 95 | 105 | | |
| | | | | –40°C to 85°C | 90 | | | |
| | | $R_L$ = 2 kΩ to 2.5 V, $V_O$ = 2.5 V to 0.5 V | Sinking | 25°C | 95 | 105 | | |
| | | | | –40°C to 85°C | 90 | | | |
| | Output swing | $V_{CC+}$ = 5 V, $R_L$ = 600 Ω to 2.5 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 V, $R_L$ = 2 kΩ to 2.5 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 V | Sourcing | 25°C | 20 | 45 | | mA |
| | | | | –40°C to 85°C | 15 | | | |
| | | $V_O$ = 5 V | Sinking | 25°C | 20 | 40 | | |
| | | | | –40°C to 85°C | 15 | | | |

PRODUCT PREVIEW

## electrical characteristics at specified free-air temperature, $V_{CC+}$ = 5 V, GND = 0 V, $V_{CM}$ = 2 V, $V_O$ = 2.5 V, and $R_L$ > 1 MΩ (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 V† | 25°C | 2 | 2.5 | | V/μs |
| 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 V, $R_L$ = 100 kΩ to 2.5 V‡ | 25°C | | 135 | | dB |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz, $V_{CM}$ = 1 V | 25°C | | 24 | | nV/√Hz |
| $I_n$ | Equivalent input noise voltage | f = 1 kHz | 25°C | | 0.25 | | pA/√Hz |
| THD | Total harmonic distortion | f = 1 kHz, $A_{VD}$ = –2, $R_L$ = 10 kΩ, $V_O$ = 4.1 $V_{PP}$ | 25°C | | 0.01% | | |

† Connected as voltage follower with 3-V step input. Value specified is the slower of the positive and negative slew rates.
‡ Refers to inputs only. Each amplifier is excited, in turn, with 1 kHz to produce $V_O$ = 3 $V_{PP}$.

PRODUCT PREVIEW

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