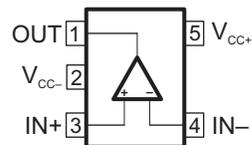


LOW-POWER SINGLE OPERATIONAL AMPLIFIER

FEATURES

- **Qualified for Automotive Applications**
- **Wide Power-Supply Range**
 - **Single Supply: 3 V to 30 V**
 - **Dual Supply: ± 1.5 V to ± 15 V**
- **Large Output Voltage Swing:**
0 V to 3.5 V (Min) ($V_{CC} = 5$ V)
- **Low Supply Current: 500 μ A (Typ)**
- **Low Input Bias Current: 20 nA (Typ)**
- **Stable With High Capacitive Loads**

**DBV (SOT-23-5) PACKAGE
(TOP VIEW)**


DESCRIPTION/ORDERING INFORMATION

The TS321 is a bipolar operational amplifier for cost-sensitive applications in which space savings are important.

ORDERING INFORMATION⁽¹⁾

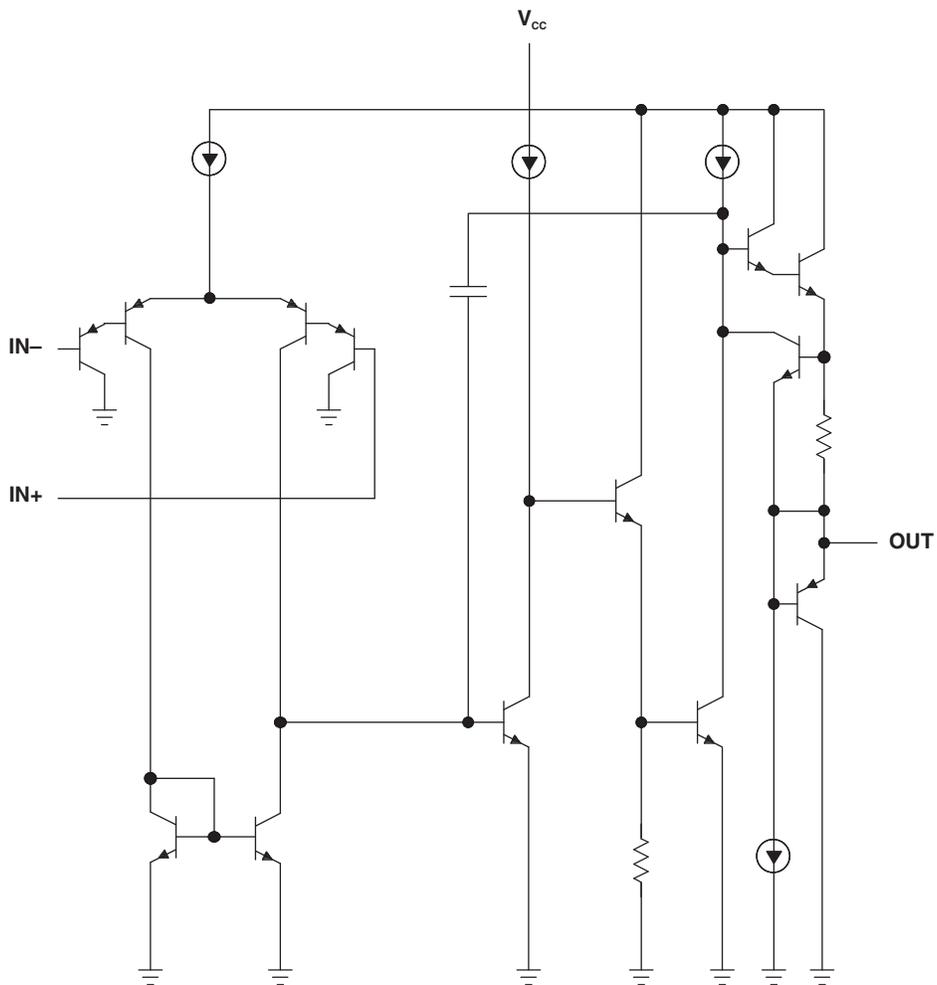
T_A	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOT-23-5 – DBV	Reel of 3000	TS321QDBVRQ1	9CNS

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
- (2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



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SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V _{CC}	Supply voltage ⁽²⁾	Single	32	V
		Dual	±16	
V _{ID}	Differential input voltage ⁽³⁾		32	V
V _I	Input voltage range ⁽²⁾⁽⁴⁾	–0.3	32	V
I _I	Input current ⁽⁴⁾		50	mA
t _{short}	Duration of output short circuit to ground		Unlimited	
θ _{JA}	Package thermal impedance, junction to free air ⁽⁵⁾⁽⁶⁾	DBV package	206	°C/W
T _J	Operating virtual junction temperature		150	°C
T _{stg}	Storage temperature range	–65	150	°C

- (1) 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.
- (2) These voltage values are with respect to the midpoint between V_{CC+} and V_{CC–}.
- (3) Differential voltages are at IN+ with respect to IN–.
- (4) Neither input must ever be more positive than V_{CC+} or more negative than V_{CC–}.
- (5) Maximum power dissipation is a function of T_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} – T_A)/θ_{JA}. Selecting the maximum of 150°C can affect reliability.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V _{CC}	Supply voltage	Single supply	3	V
		Dual supply	±1.5	
T _A	Operating free-air temperature	–40	125	°C

ELECTRICAL CHARACTERISTICS

$V_{CC+} = 5\text{ V}$, $V_{CC-} = \text{GND}$, $V_O = 1.4\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$R_S = 0$, $5\text{ V} < V_{CC+} < 30\text{ V}$, $0 < V_{IC} < (V_{CC+} - 1.5\text{ V})$		25°C		0.5	4	mV
				Full range			5	
I_{IO}	Input offset current			25°C		2	30	nA
				Full range			50	
I_{IB}	Input bias current ⁽¹⁾			25°C		20	150	nA
				Full range			200	
A_{VD}	Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}$, $R_L = 2\text{ k}\Omega$, $V_O = 1.4\text{ V}$ to 11.4 V		25°C	50	100		V/mV
				Full range	25			
V_{ICR}	Common-mode input voltage ⁽²⁾	$V_{CC} = 30\text{ V}$		25°C	0		$V_{CC+} - 1.5$	V
				Full range	0		$V_{CC+} - 2$	
V_{OH}	High-level output voltage	$V_{CC} = 30\text{ V}$	$R_L = 2\text{ k}\Omega$	25°C	26	27		V
				Full range	25.5			
			$R_L = 10\text{ k}\Omega$	25°C	27	28		
				Full range	26.5			
		$V_{CC} = 5\text{ V}$	$R_L = 2\text{ k}\Omega$	25°C	3.5			
				Full range	3			
V_{OL}	Low-level output voltage	$R_L = 10\text{ k}\Omega$		25°C		5	15	mV
				Full range			20	
GBP	Gain bandwidth product	$V_{CC} = 30\text{ V}$, $V_I = 10\text{ mV}$, $R_L = 2\text{ k}\Omega$, $f = 100\text{ kHz}$, $C_L = 100\text{ pF}$		25°C		0.8		MHz
SR	Slew rate	$V_{CC} = 15\text{ V}$, $V_I = 0.5\text{ V}$ to 3 V , $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, unity gain		25°C		0.4		V/ μs
ϕ_m	Phase margin			25°C		60		°
CMRR	Common-mode rejection ratio	$R_S \leq 10\text{ k}\Omega$		25°C	65	85		dB
I_{SOURCE}	Output source current	$V_{CC} = 15\text{ V}$, $V_O = 2\text{ V}$, $V_{ID} = 1\text{ V}$		25°C	20	40		mA
I_{SINK}	Output sink current	$V_{CC} = 15\text{ V}$, $V_{ID} = 1\text{ V}$		$V_O = 2\text{ V}$	25°C	10	20	mA
				$V_O = 0.2\text{ V}$	25°C	12	50	μA
I_O	Short-circuit to GND	$V_{CC} = 15\text{ V}$		25°C		40	60	mA
SVR	Supply-voltage rejection ratio	$V_{CC} = 5\text{ V}$ to 30 V		25°C	65	110		dB
I_{CC}	Total supply current	No load		25°C	$V_{CC} = 5\text{ V}$	500	800	μA
					$V_{CC} = 30\text{ V}$	600	900	
				Full range	$V_{CC} = 5\text{ V}$	600	900	
					$V_{CC} = 30\text{ V}$		1000	
THD	Total harmonic distortion	$V_{CC} = 30\text{ V}$, $V_O = 2\text{ V}_{pp}$, $A_V = 20\text{ dB}$, $R_L = 2\text{ k}\Omega$, $f = 1\text{ kHz}$, $C_L = 100\text{ pF}$		25°C		0.015		%
e_N	Equivalent input noise voltage	$V_{CC} = 30\text{ V}$, $f = 1\text{ kHz}$, $R_S = 100\ \Omega$		25°C		50		nV/ $\sqrt{\text{Hz}}$

- (1) The direction of the input current is out of the device. This current essentially is constant, independent of the state of the output, so no loading change exists on the input lines.
- (2) The input common-mode voltage of either input signal should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is $V_{CC+} - 1.5\text{ V}$, but either or both inputs can go to 32 V without damage.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TS321QDBVRQ1	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	9CNS
TS321QDBVRQ1.A	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	9CNS

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OTHER QUALIFIED VERSIONS OF TS321-Q1 :

- Catalog : [TS321](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TS321QDBVRQ1	SOT-23	DBV	5	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

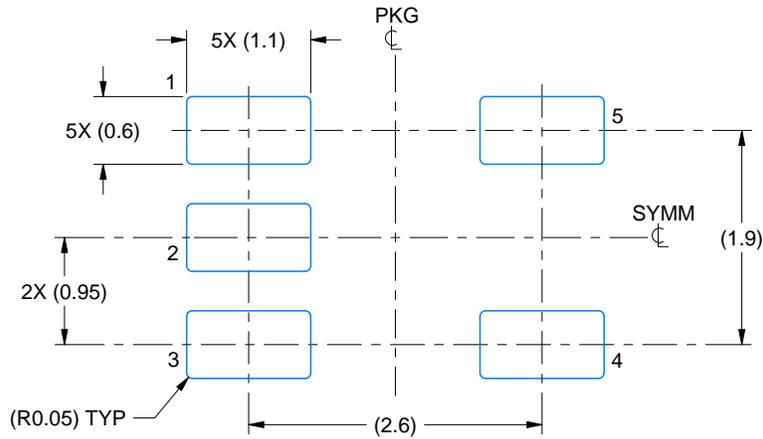
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS321QDBVRQ1	SOT-23	DBV	5	3000	202.0	201.0	28.0

EXAMPLE BOARD LAYOUT

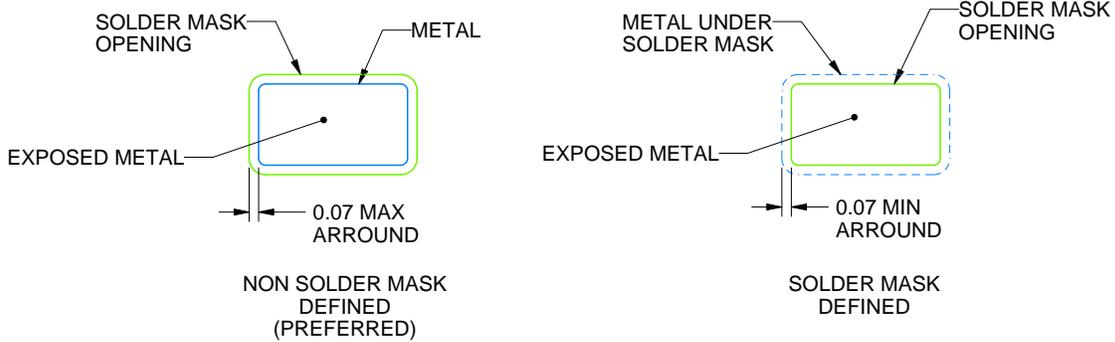
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

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NOTES: (continued)

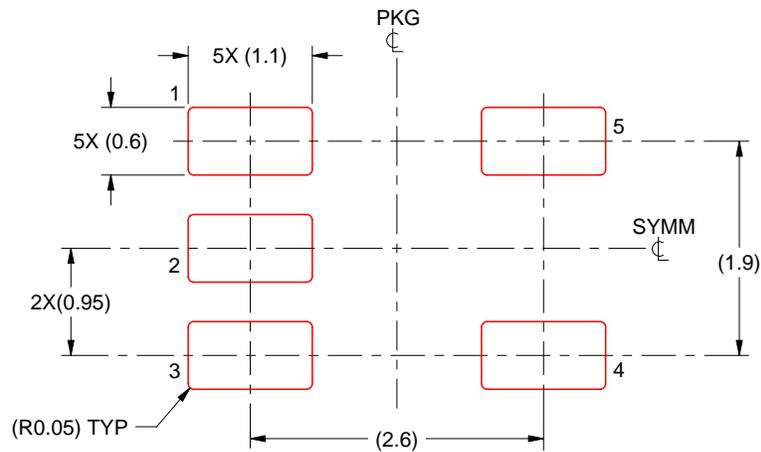
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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