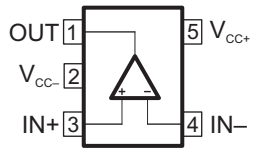
LOW-POWER SINGLE OPERATIONAL AMPLIFIER

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 μA (Typ)**
- **Low Input Bias Current: 20 nA (Typ)**
- **Stable With High Capacitive Loads**

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



DESCRIPTION/ORDERING INFORMATION

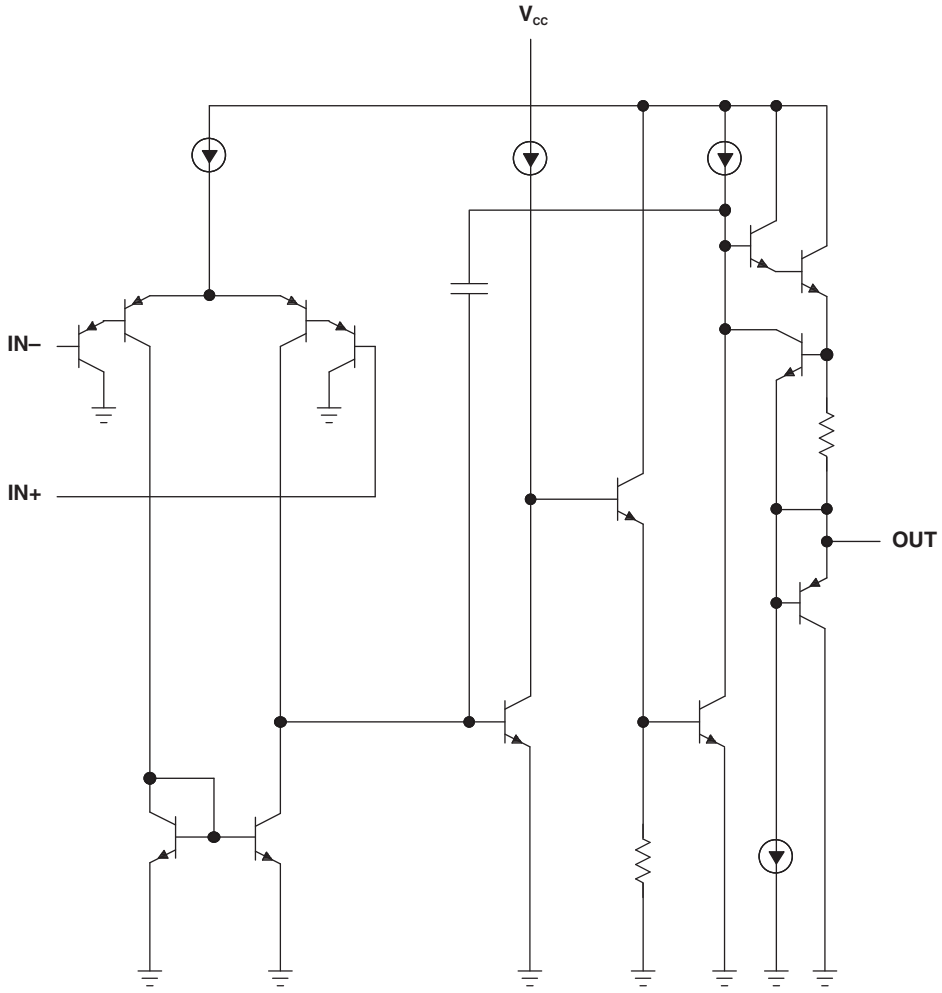
The TS321 is a bipolar operational amplifier for cost-sensitive applications in which space savings are important.

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.

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 $P_D = (T_J(max) – T_A)/\theta_{JA}$. 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	30	V
		Dual supply	±1.5	±15	
T_A	Operating free-air temperature		–40	125	°C

ELECTRICAL CHARACTERISTICS

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

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

OTHER QUALIFIED VERSIONS OF TS321-Q1 :

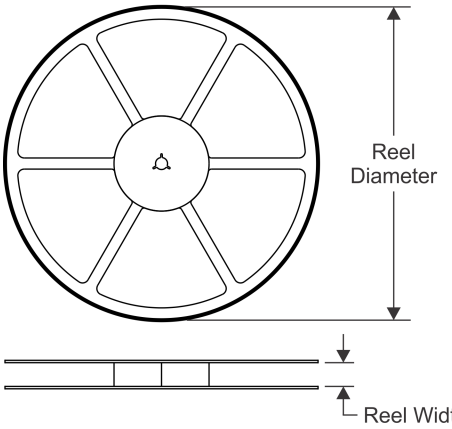
- Catalog : TS321

NOTE: Qualified Version Definitions:

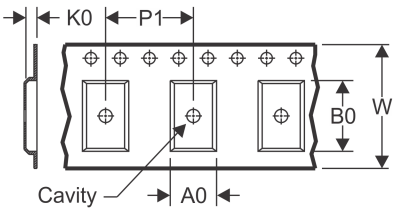
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

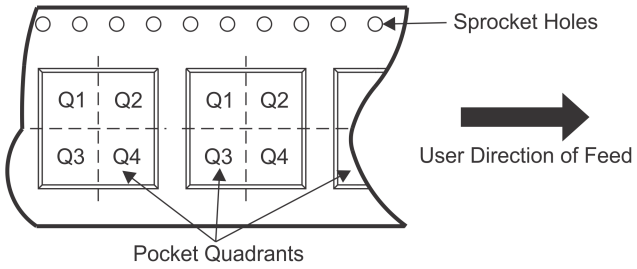


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

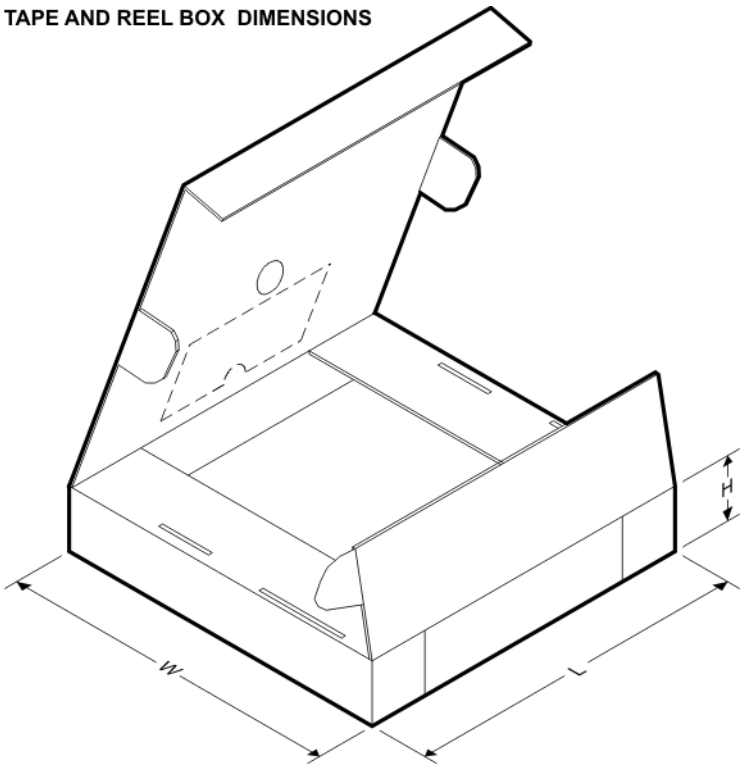
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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

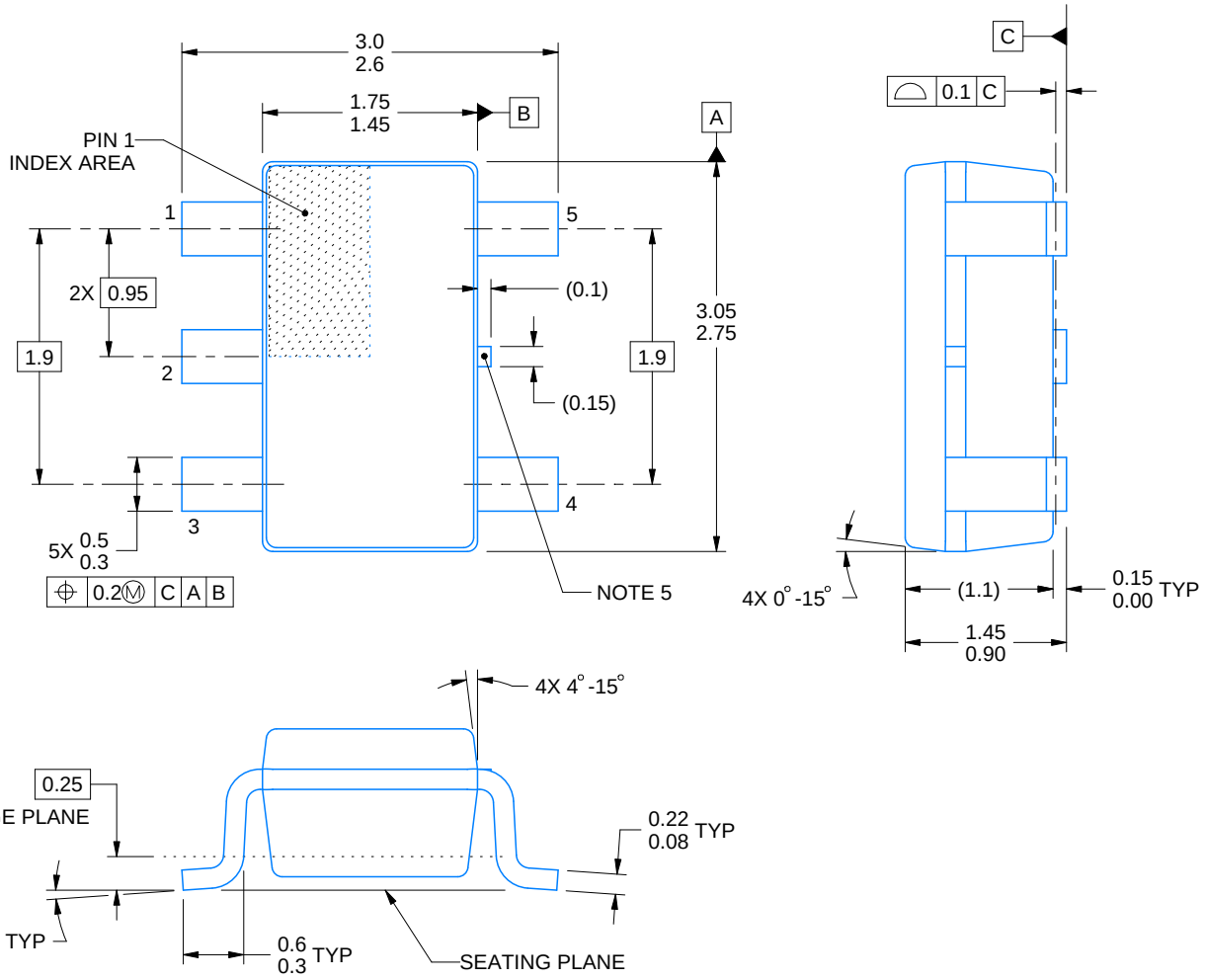
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS321QDBVRQ1	SOT-23	DBV	5	3000	202.0	201.0	28.0

PACKAGE OUTLINE

DBV0005A

SOT-23 - 1.45 mm max height

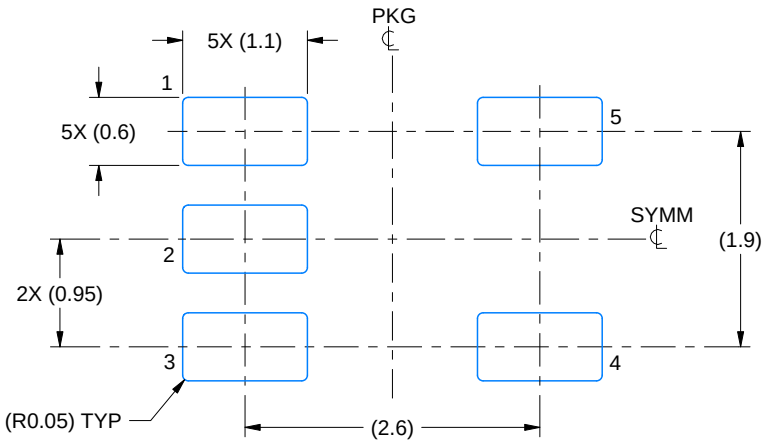
SMALL OUTLINE TRANSISTOR



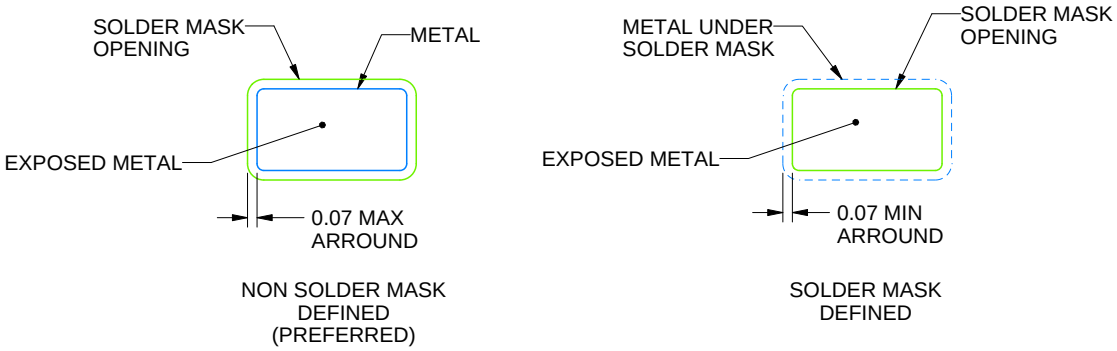
4214839/K 08/2024

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Refernce JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
5. Support pin may differ or may not be present.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

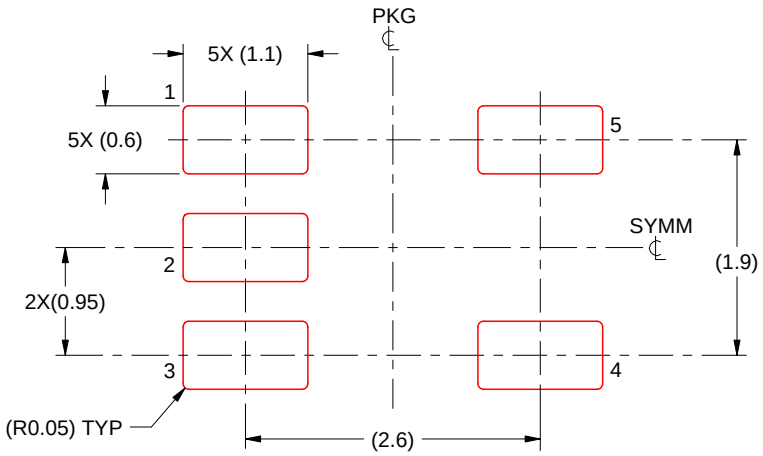


SOLDER MASK DETAILS

4214839/K 08/2024

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.



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

4214839/K 08/2024

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.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale, TI’s General Quality Guidelines, or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Last updated 10/2025