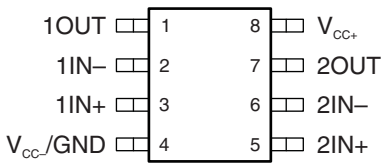
HIGH-SLEW-RATE SINGLE-SUPPLY OPERATIONAL AMPLIFIER

FEATURES

- **Qualified for Automotive Applications**
- **Wide Gain-Bandwidth Product: 4 MHz**
- **High Slew Rate: 13 V/μs**
- **Fast Settling Time: 1.1 μs to 0.1%**
- **Wide-Range Single-Supply Operation: 4 V to 36 V**
- **Wide Input Common-Mode Range Includes Ground (V_{CC-})**
- **Low Total Harmonic Distortion: 0.02%**
- **Large-Capacitance Drive Capability: 10,000 pF**
- **Output Short-Circuit Protection**

D PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

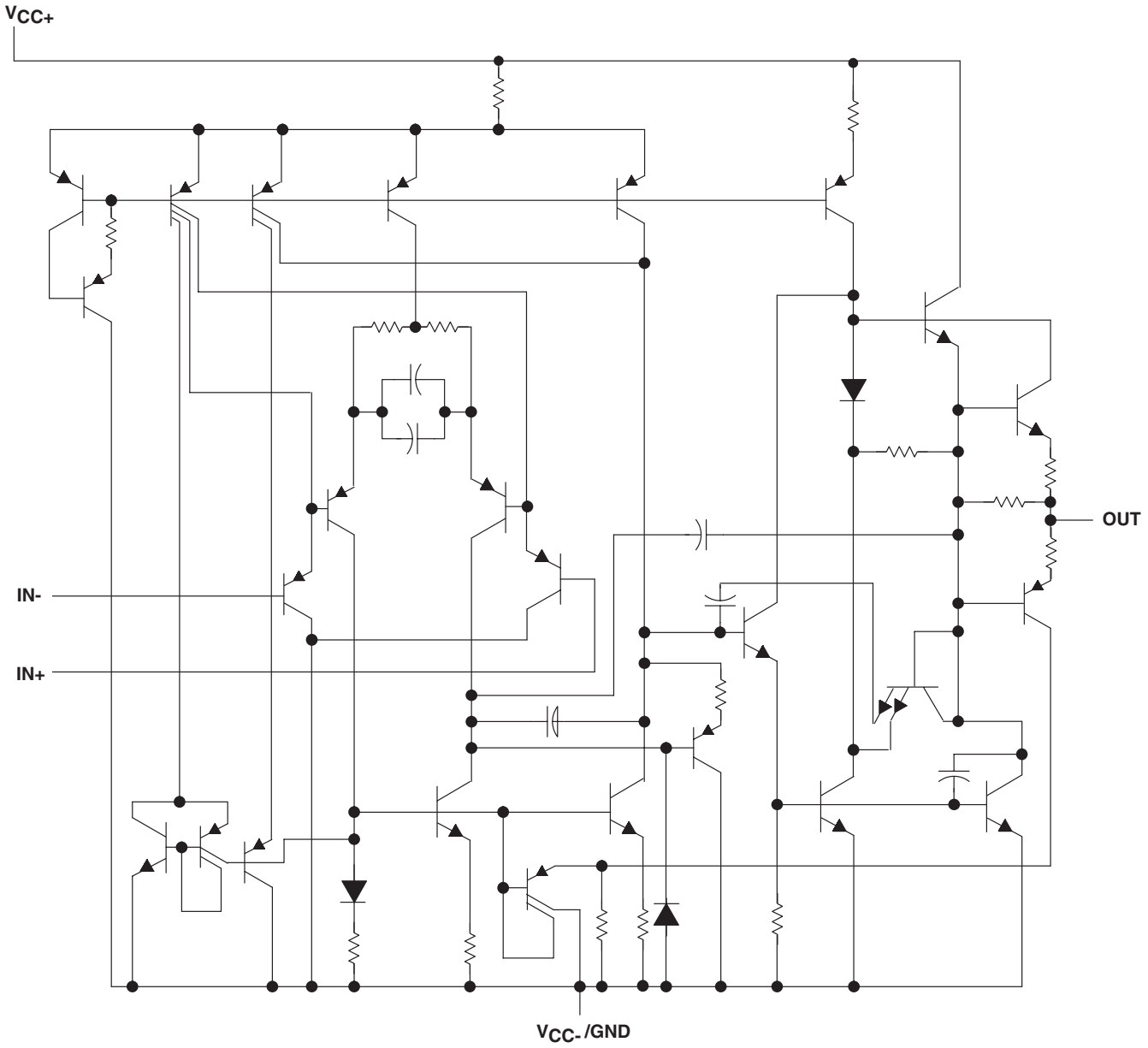
Quality, low-cost, bipolar fabrication with innovative design concepts is employed for the TL3472 operational amplifier. This device offers 4 MHz of gain-bandwidth product, 13-V/μs slew rate, and fast settling time, without the use of JFET device technology. Although the TL3472 can be operated from split supplies, it is particularly suited for single-supply operation because the common-mode input voltage range includes ground potential (V_{CC-}). With a Darlington transistor input stage, this device exhibits high input resistance, low input offset voltage, and high gain. The all-npn output stage, characterized by no dead-band crossover distortion and large output voltage swing, provides high-capacitance drive capability, excellent phase and gain margins, low open-loop high-frequency output impedance, and symmetrical source/sink ac frequency response. This low-cost amplifier is an alternative to the MC33072 and the MC34072 operational amplifiers.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOIC – D	Reel of 2500	TL3472QDRQ1	T3472Q

(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 (EACH AMPLIFIER)



ABSOLUTE MAXIMUM RATINGS(1)

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

V_{CC+}	Supply voltage(2)	18 V
$V_{CC–}$		–18 V
V_{ID}	Differential input voltage	±36 V
V_I	Input voltage (any input)	$V_{CC±}$
I_I	Input current (each input)	±1 mA
I_O	Output current	±80 mA
	Total current into V_{CC+}	80 mA
	Total current out of $V_{CC–}$	80 mA
	Duration of short-circuit current at (or below) 25°C(3)	Unlimited
θ_{JA}	Package thermal impedance(4)(5)	97°C/W
T_J	Operating virtual junction temperature	150°C
	Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds	260°C
T_{stg}	Storage temperature range	–65°C to 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) All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and $V_{CC–}$.
(3) The output can be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.
(4) 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 $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can impact reliability.
(5) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

			MIN	MAX	UNIT
$V_{CC±}$	Supply voltage		4	36	V
V_{IC}	Common-mode input voltage	V_{CC} = 5 V	0	2.8	V
		$V_{CC±}$ = ±15 V	–15	12.8	
T_A	Operating free-air temperature		–40	125	°C

ELECTRICAL CHARACTERISTICS

at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A (1)	MIN	TYP (2)	MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0, R_S = 50 Ω	V_{CC} = 5 V	25°C		1.5	16	mV
			V_{CC} = ±15 V	25°C		1	17	
				Full range			22	
α_{VIO}	Temperature coefficient of input offset voltage	V_{IC} = 0, V_O = 0, R_S = 50 Ω	V_{CC} = ±15 V	Full range		10		µV/°C
I_{IO}	Input offset current	V_{IC} = 0, V_O = 0, R_S = 50 Ω	V_{CC} = ±15 V	25°C		6	75	nA
				Full range			300	
I_{IB}	Input bias current	V_{IC} = 0, V_O = 0, R_S = 50 Ω	V_{CC} = ±15 V	25°C		100	500	nA
				Full range			700	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		25°C		–15 to 12.8		V
				Full range		–15 to 12.8		
V_{OH}	High-level output voltage	V_{CC+} = 5 V, V_{CC-} = 0, R_L = 2 kΩ		25°C	3.7	4		V
		R_L = 10 kΩ		25°C	13.6	14		
		R_L = 2 kΩ		Full range	13.4			
V_{OL}	Low-level output voltage	V_{CC+} = 5 V, V_{CC-} = 0, R_L = 2 kΩ		25°C		0.1	0.3	V
		R_L = 10 kΩ		25°C		–14.7	–14.3	
		R_L = 2 kΩ		Full range			–13.5	
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L = 2 kΩ		25°C	25	100		V/mV
				Full range	20			
I_{OS}	Short-circuit output current	Source: VID = 1 V, V_O = 0		25°C	–10	–34		mA
		Sink: VID = –1 V, V_O = 0			20	27		
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}(min), R_S = 50 Ω		25°C	65	97		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±13.5 V to ±16.5 V, R_S = 100 Ω		25°C	70	97		dB
I_{CC}	Supply current (per channel)	V_O = 0, No load		25°C		3.5	4.5	mA
				Full range		4.5	5.5	
		V_{CC+} = 5 V, V_O = 2.5 V, V_{CC-} = 0, No load		25°C		3.5	4.5	

(1) Full range T_A = –40°C to 125°C
(2) All typical values are at T_A = 25°C.

OPERATING CHARACTERISTICS

$V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SR+	Positive slew rate	V_I = –10 V to 10 V, R_L = 2 kΩ, C_L = 300 pF	A_V = 1	8	10		V/µs
SR–	Negative slew rate	V_I = –10 V to 10 V, R_L = 2 kΩ, C_L = 300 pF	A_V = –1		13		V/µs
t_s	Settling time	A_{VD} = –1, 10-V step	To 0.1%		1.1		µs
			To 0.01%		2.2		
V_n	Equivalent input noise voltage	f = 1 kHz, R_S = 100 Ω			49		nV/√Hz
I_n	Equivalent input noise current	f = 1 kHz			0.22		pA/√Hz
THD	Total harmonic distortion	$V_{O(PP)}$ = 2 V to 20 V, R_L = 2 kΩ, A_{VD} = 10, f = 10 kHz			0.02		%
GBW	Gain-bandwidth product	f =100 kHz		3	4		MHz
BW	Power bandwidth	$V_{O(PP)}$ = 20 V, R_L = 2 kΩ, A_{VD} = 1, THD = 5.0%			160		kHz
ϕ_m	Phase margin	R_L = 2 kΩ	C_L = 0		70		deg
			C_L = 300 pF		50		
	Gain margin	R_L = 2 kΩ	C_L = 0		12		dB
			C_L = 300 pF		4		
r_i	Differential input resistance	V_{IC} = 0			150		MΩ
C_i	Input capacitance	V_{IC} = 0			2.5		pF
	Channel separation	f = 10 kHz			101		dB
z_o	Open-loop output impedance	f = 1 MHz, A_V = 1			20		Ω

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)
TL3472QDRQ1	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	T3472Q
TL3472QDRQ1.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	T3472Q

(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 TL3472-Q1 :

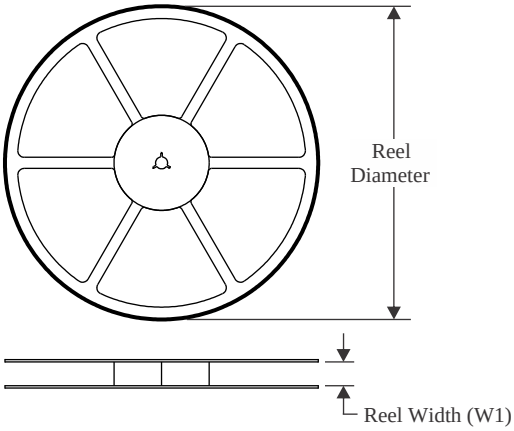
- Catalog : TL3472

NOTE: Qualified Version Definitions:

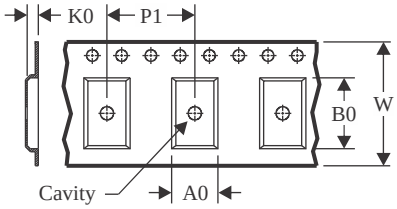
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

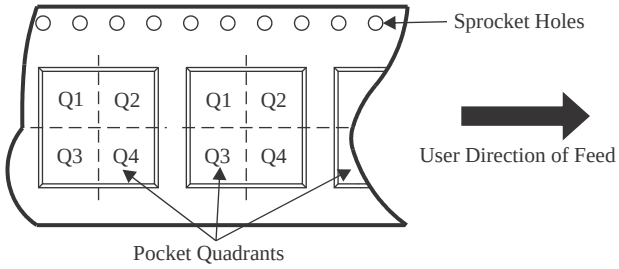


TAPE DIMENSIONS



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

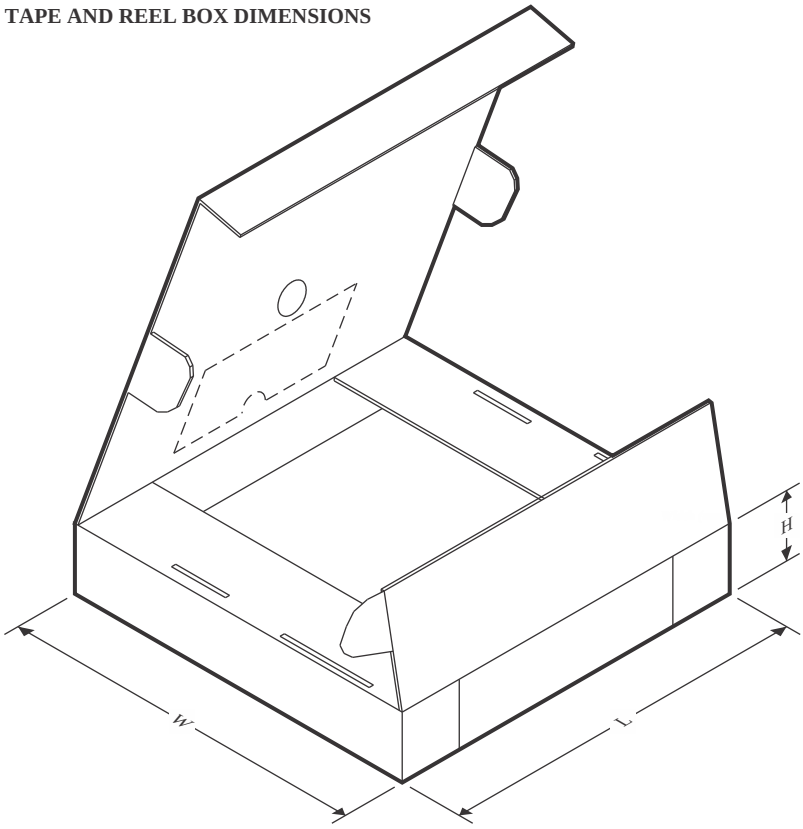
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

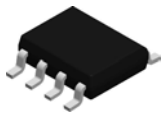
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TL3472QDRQ1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL3472QDRQ1	SOIC	D	8	2500	353.0	353.0	32.0

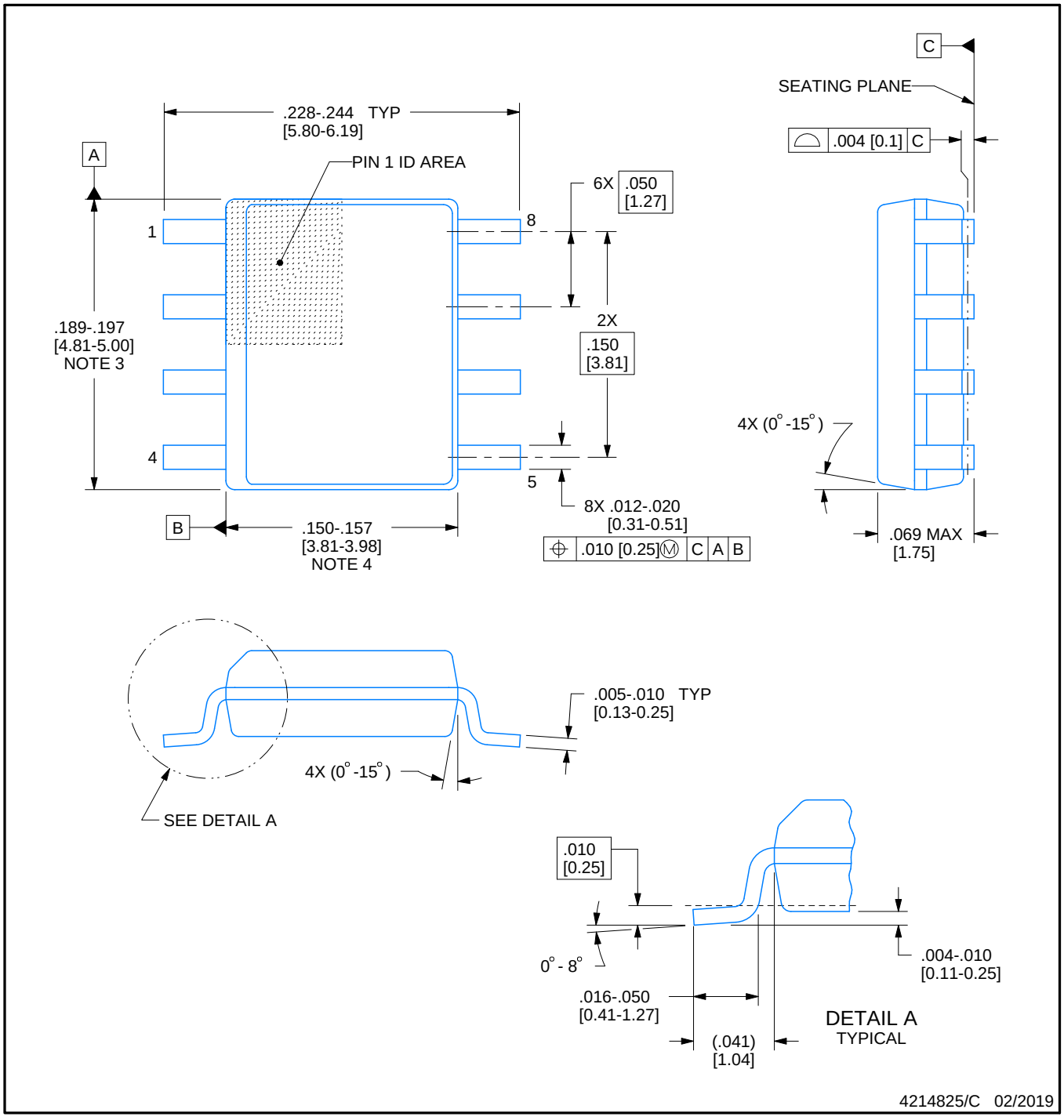


PACKAGE OUTLINE

D0008A

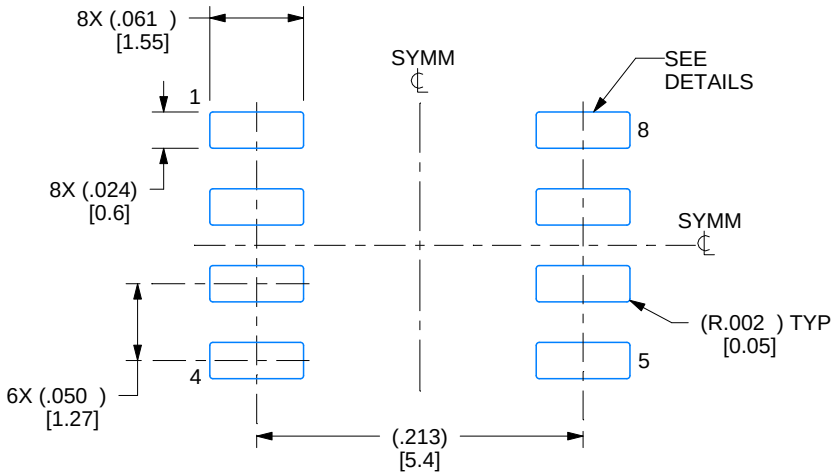
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

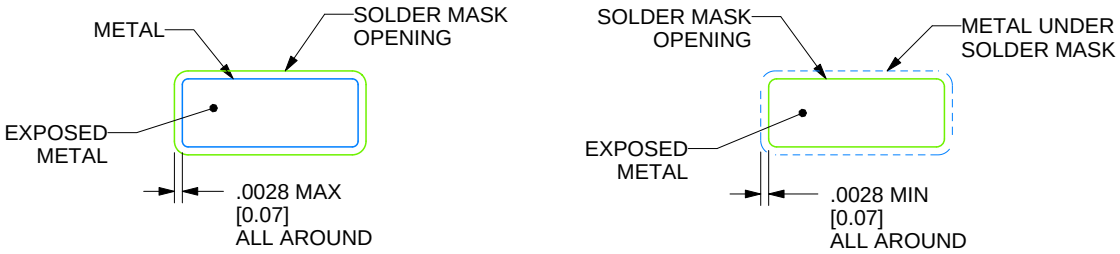


NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

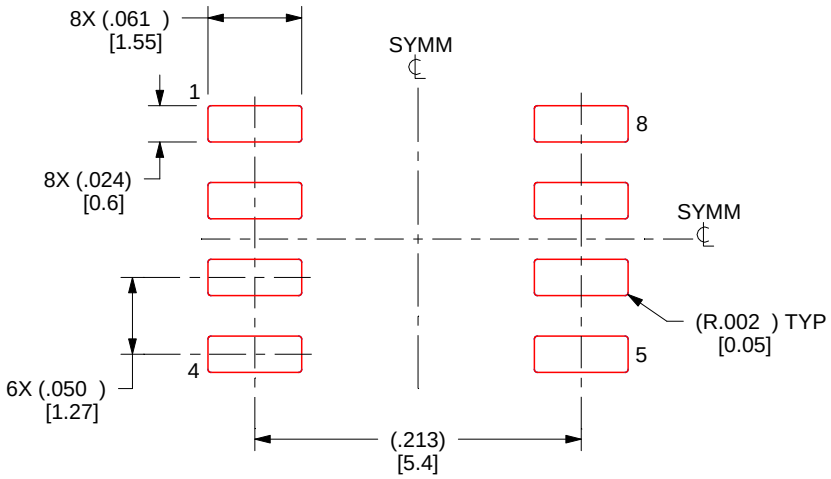
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

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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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