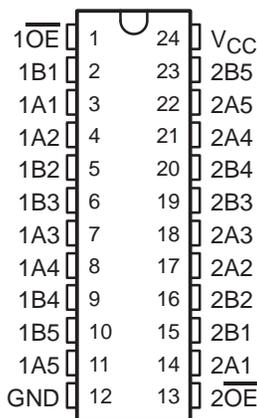


2.5-V/3.3-V LOW-VOLTAGE BUS SWITCH WITH 5-V-TOLERANT LEVEL SHIFTER

SCDS159B – OCTOBER 2003 – REVISED MARCH 2004

- Output Voltage Translation Tracks V_{CC}
- Supports Mixed-Mode Signal Operation On All Data I/O Ports
 - 5-V Input Down To 3.3-V Output Level Shift With 3.3-V V_{CC}
 - 5-V/3.3-V Input Down To 2.5-V Output Level Shift With 2.5-V V_{CC}
- 5-V-Tolerant I/Os With Device Powered-Up or Powered-Down
- Bidirectional Data Flow, With Near-Zero Propagation Delay
- Low ON-State Resistance (r_{ON}) Characteristics ($r_{ON} = 5 \Omega$ Typical)
- Low Input/Output Capacitance Minimizes Loading ($C_{iO(OFF)} = 5 \text{ pF}$ Typical)
- Data and Control Inputs Provide Undershoot Clamp Diodes
- Low Power Consumption ($I_{CC} = 40 \mu\text{A}$ Max)
- V_{CC} Operating Range From 2.3 V to 3.6 V
- Data I/Os Support 0 to 5-V Signaling Levels (For Example: 0.8-V, 1.2-V, 1.5-V, 1.8-V, 2.5-V, 3.3-V, 5-V)
- Control Inputs Can Be Driven by TTL or 5-V/3.3-V/2.5-V CMOS Outputs
- I_{off} Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Performance Tested Per JESD 22
 - 2000-V Human-Body Model (A114-B, Class II)
 - 1000-V Charged-Device Model (C101)
- Supports Digital Applications: Level Translation, Memory Interleaving, Bus Isolation
- Ideal for Low-Power Portable Equipment

DBQ, DGV, DW, OR PW PACKAGE
(TOP VIEW)



description/ordering information

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SOIC – DW	Tube	SN74CB3T3384DW	CB3T3384
		Tape and reel	SN74CB3T3384DWR	
	SSOP (QSOP) – DBQ	Tape and reel	SN74CB3T3384DBQR	CB3T3384
		TSSOP – PW	Tube	SN74CB3T3384PW
	Tape and reel		SN74CB3T3384PWR	
	TVSOP – DGV	Tape and reel	SN74CB3T3384DGVR	GE PREVIEW

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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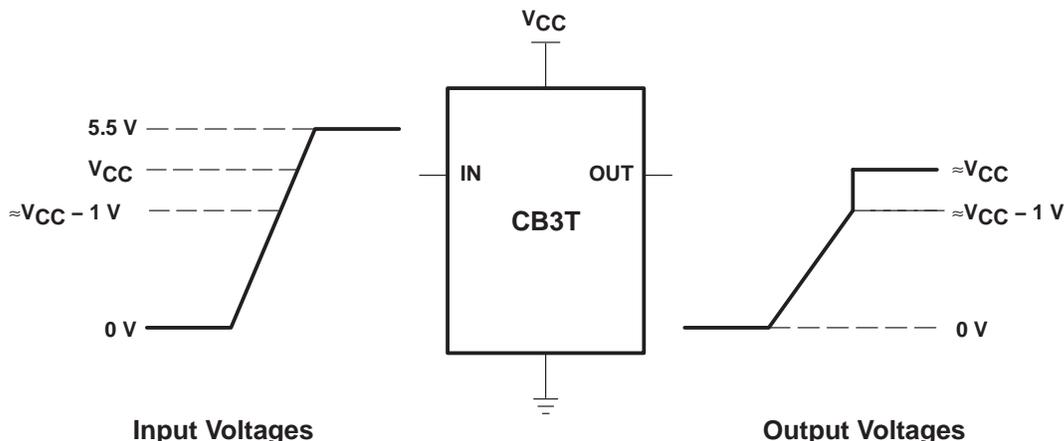
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SN74CB3T3384
10-BIT FET BUS SWITCH
2.5-V/3.3-V LOW-VOLTAGE BUS SWITCH WITH 5-V-TOLERANT LEVEL SHIFTER

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description/ordering information (continued)

The SN74CB3T3384 is a high-speed TTL-compatible FET bus switch with low ON-state resistance (r_{on}), allowing for minimal propagation delay. The device fully supports mixed-mode signal operation on all data I/O ports by providing voltage translation that tracks V_{CC} . The SN74CB3T3384 supports systems using 5-V TTL, 3.3-V LVTTTL, and 2.5-V CMOS switching standards, as well as user-defined switching levels (see Figure 1).



NOTE A: If the input high voltage (V_{IH}) level is greater than or equal to $V_{CC} - 1\text{ V}$, and less than or equal to 5.5 V, the output high voltage (V_{OH}) level will be equal to approximately the V_{CC} voltage level.

Figure 1. Typical DC-Voltage-Translation Characteristics

The SN74CB3T3384 is organized as two 5-bit bus switches with separate output-enable ($\overline{1OE}$, $\overline{2OE}$) inputs. It can be used as two 5-bit bus switches or as one 10-bit bus switch. When \overline{OE} is low, the associated 5-bit bus switch is ON, and the A port is connected to the B port, allowing bidirectional data flow between ports. When \overline{OE} is high, the associated 5-bit bus switch is OFF, and a high-impedance state exists between the A and B ports.

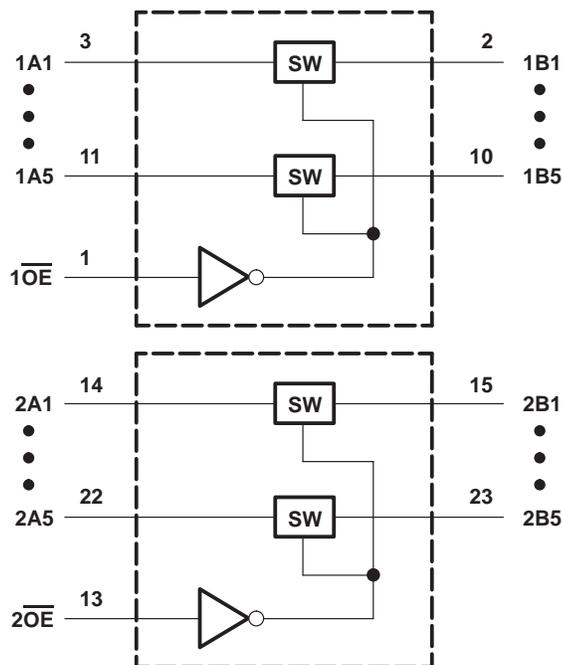
This device is fully specified for partial-power-down applications using I_{off} . The I_{off} feature ensures that damaging current will not backflow through the device when it is powered down. The device has isolation during power off.

To ensure the high-impedance state during power up or power down, \overline{OE} should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

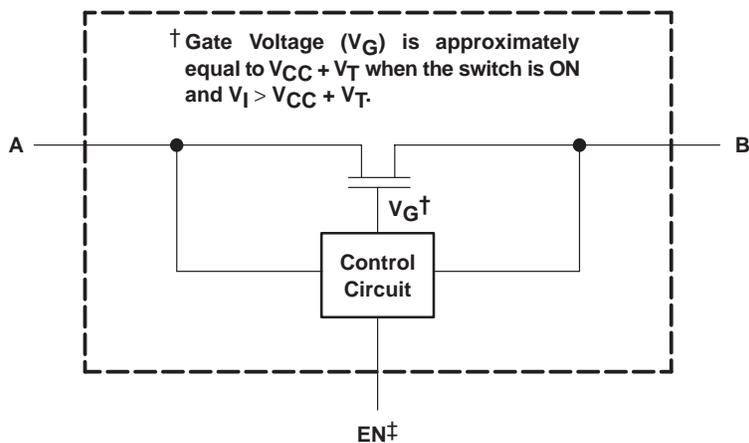
FUNCTION TABLE
 (each 5-bit bus switch)

INPUT \overline{OE}	INPUT/OUTPUT A	FUNCTION
L	B	A port = B port
H	Z	Disconnect

logic diagram (positive logic)



simplified schematic, each FET switch (SW)



† EN is the internal enable signal applied to the switch.

SN74CB3T3384

10-BIT FET BUS SWITCH

2.5-V/3.3-V LOW-VOLTAGE BUS SWITCH WITH 5-V-TOLERANT LEVEL SHIFTER

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC} (see Note 1)	–0.5 V to 7 V
Control input voltage range, V_{IN} (see Notes 1 and 2)	–0.5 V to 7 V
Switch I/O voltage range, $V_{I/O}$ (see Notes 1, 2, and 3)	–0.5 V to 7 V
Control input clamp current, I_{IK} ($V_{IN} < 0$)	–50 mA
I/O port clamp current, $I_{I/OK}$ ($V_{I/O} < 0$)	–50 mA
ON-state switch current, $I_{I/O}$ (see Note 4)	±128 mA
Continuous current through V_{CC} or GND terminals	±100 mA
Package thermal impedance, θ_{JA} (see Note 5): DBQ package	61°C/W
DGV package	86°C/W
DW package	46°C/W
PW package	88°C/W
Storage temperature range, T_{stg}	–65°C 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 voltages are with respect to ground unless otherwise specified.
 2. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
 3. V_I and V_O are used to denote specific conditions for $V_{I/O}$.
 4. I_I and I_O are used to denote specific conditions for $I_{I/O}$.
 5. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 6)

		MIN	MAX	UNIT	
V_{CC}	Supply voltage	2.3	3.6	V	
V_{IH}	High-level control input voltage	$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	1.7	5.5	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	2	5.5	
V_{IL}	Low-level control input voltage	$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	0	0.7	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	0	0.8	
$V_{I/O}$	Data input/output voltage	0	5.5	V	
T_A	Operating free-air temperature	–40	85	°C	

NOTE 6: All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



2.5-V/3.3-V LOW-VOLTAGE BUS SWITCH WITH 5-V-TOLERANT LEVEL SHIFTER

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

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT	
V _{IK}		V _{CC} = 3 V, I _I = -18 mA			-1.2	V	
V _{OH}		See Figures 3 and 4					
I _{IN}	Control inputs	V _{CC} = 3.6 V, V _{IN} = 3.6 V to 5.5 V or GND			±10	μA	
I _I		V _{CC} = 3.6 V, Switch ON, V _{IN} = GND	V _I = V _{CC} - 0.7 V to 5.5 V		±20	μA	
			V _I = 0.7 V to V _{CC} - 0.7 V		-40		
			V _I = 0 to 0.7 V		±5		
I _{OZ} ‡		V _{CC} = 3.6 V, V _O = 0 to 5.5 V, V _I = 0, Switch OFF, V _{IN} = V _{CC}			±10	μA	
I _{off}		V _{CC} = 0, V _O = 0 to 5.5 V, V _I = 0			10	μA	
I _{CC}		V _{CC} = 3.6 V, I _{I/O} = 0, Switch ON or OFF, V _{IN} = V _{CC} or GND	V _I = V _{CC} or GND		40	μA	
			V _I = 5.5 V		40		
ΔI _{CC} §	Control inputs	V _{CC} = 3 V to 3.6 V, One input at V _{CC} - 0.6 V, Other inputs at V _{CC} or GND			300	μA	
C _{in}	Control inputs	V _{CC} = 3.3 V, V _{IN} = V _{CC} or GND			3	pF	
C _{io(OFF)}		V _{CC} = 3.3 V, V _{I/O} = 5.5 V, 3.3 V, or GND, Switch OFF, V _{IN} = V _{CC}			5	pF	
C _{io(ON)}		V _{CC} = 3.3 V, Switch ON, V _{IN} = GND	V _{I/O} = 5.5 V or 3.3 V		4	pF	
			V _{I/O} = GND		12		
r _{on} ¶		V _{CC} = 2.3 V, TYP at V _{CC} = 2.5 V, V _I = 0	I _O = 24 mA		5	Ω	
			I _O = 16 mA		5		
		V _{CC} = 3 V, V _I = 0		I _O = 64 mA			5
		I _O = 32 mA		5			

V_{IN} and I_{IN} refer to control inputs. V_I, V_O, I_I, and I_O refer to data pins.

† All typical values are at V_{CC} = 3.3 V (unless otherwise noted), T_A = 25°C.

‡ For I/O ports, the parameter I_{OZ} includes the input leakage current.

§ This is the increase in supply current for each input that is at the specified TTL voltage level, rather than V_{CC} or GND.

¶ Measured by the voltage drop between A and B terminals at the indicated current through the switch. ON-state resistance is determined by the lower of the voltages of the two (A or B) terminals.

SN74CB3T3384

10-BIT FET BUS SWITCH

2.5-V/3.3-V LOW-VOLTAGE BUS SWITCH WITH 5-V-TOLERANT LEVEL SHIFTER

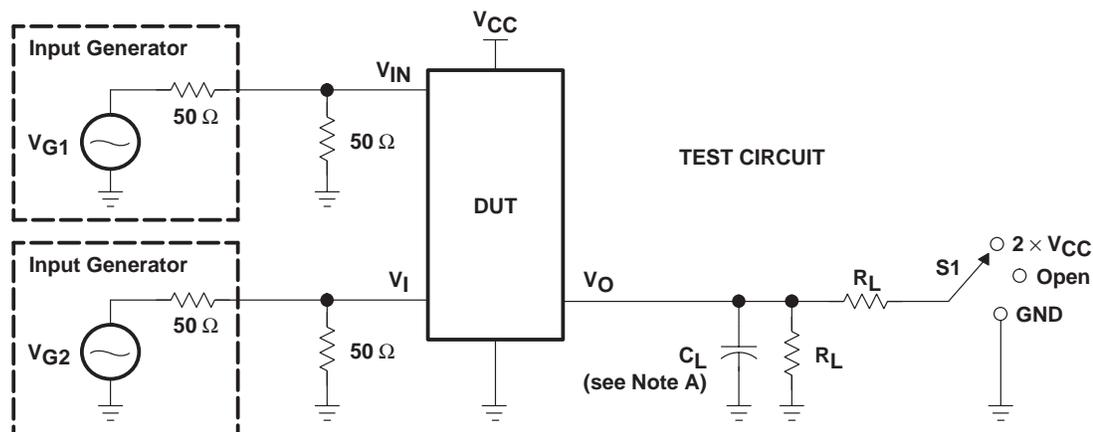
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switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

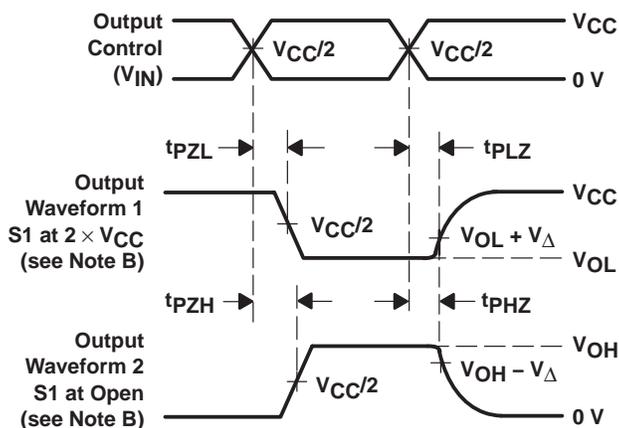
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V _{CC} = 2.5 V ± 0.2 V		V _{CC} = 3.3 V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	
t _{pd} [†]	A or B	B or A	0.15		0.25		ns
t _{en}	\overline{OE}	A or B	1	10.5	1	7.5	ns
t _{dis}	\overline{OE}	A or B	1	6.5	1	8	ns

[†] The propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).

PARAMETER MEASUREMENT INFORMATION



TEST	V _{CC}	S1	R _L	V _I	C _L	V _Δ
t _{PLZ} /t _{PZL}	2.5 V ± 0.2 V	2 × V _{CC}	500 Ω	GND	30 pF	0.15 V
	3.3 V ± 0.3 V	2 × V _{CC}	500 Ω	GND	50 pF	0.3 V
t _{PHZ} /t _{PZH}	2.5 V ± 0.2 V	Open	500 Ω	3.6 V	30 pF	0.15 V
	3.3 V ± 0.3 V	Open	500 Ω	5.5 V	50 pF	0.3 V



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- NOTES: A. C_L includes probe and jig capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
 C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
 D. The outputs are measured one at a time, with one transition per measurement.
 E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
 F. t_{PZL} and t_{PZH} are the same as t_{en}.

Figure 2. Test Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS

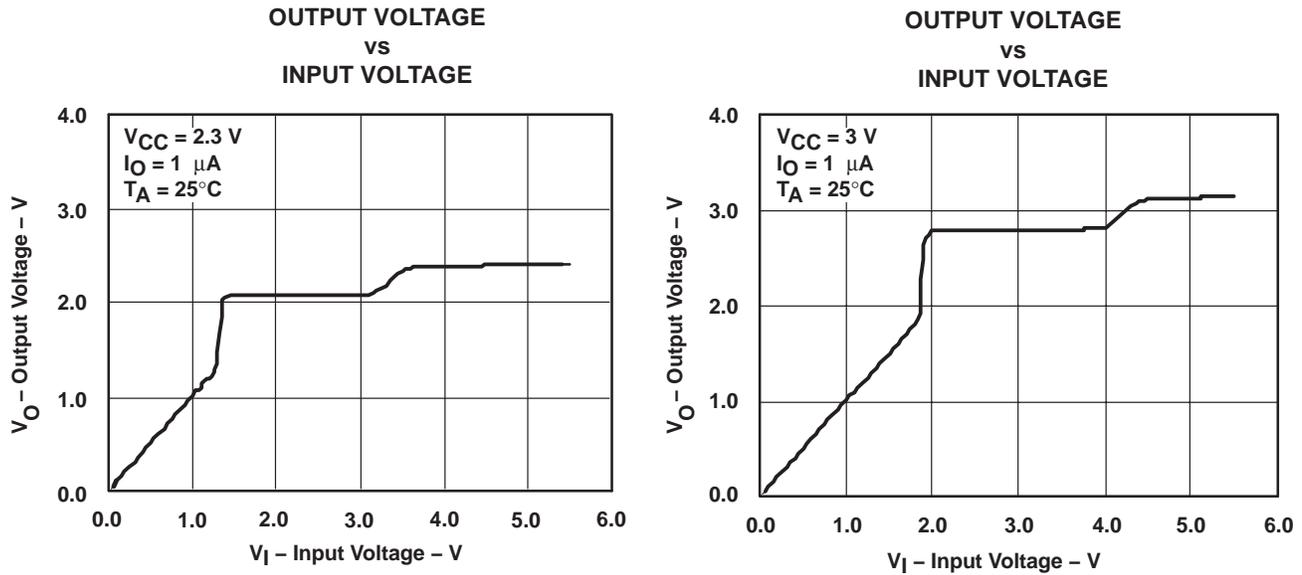


Figure 3. Data Output Voltage vs Data Input Voltage

TYPICAL CHARACTERISTICS (continued)

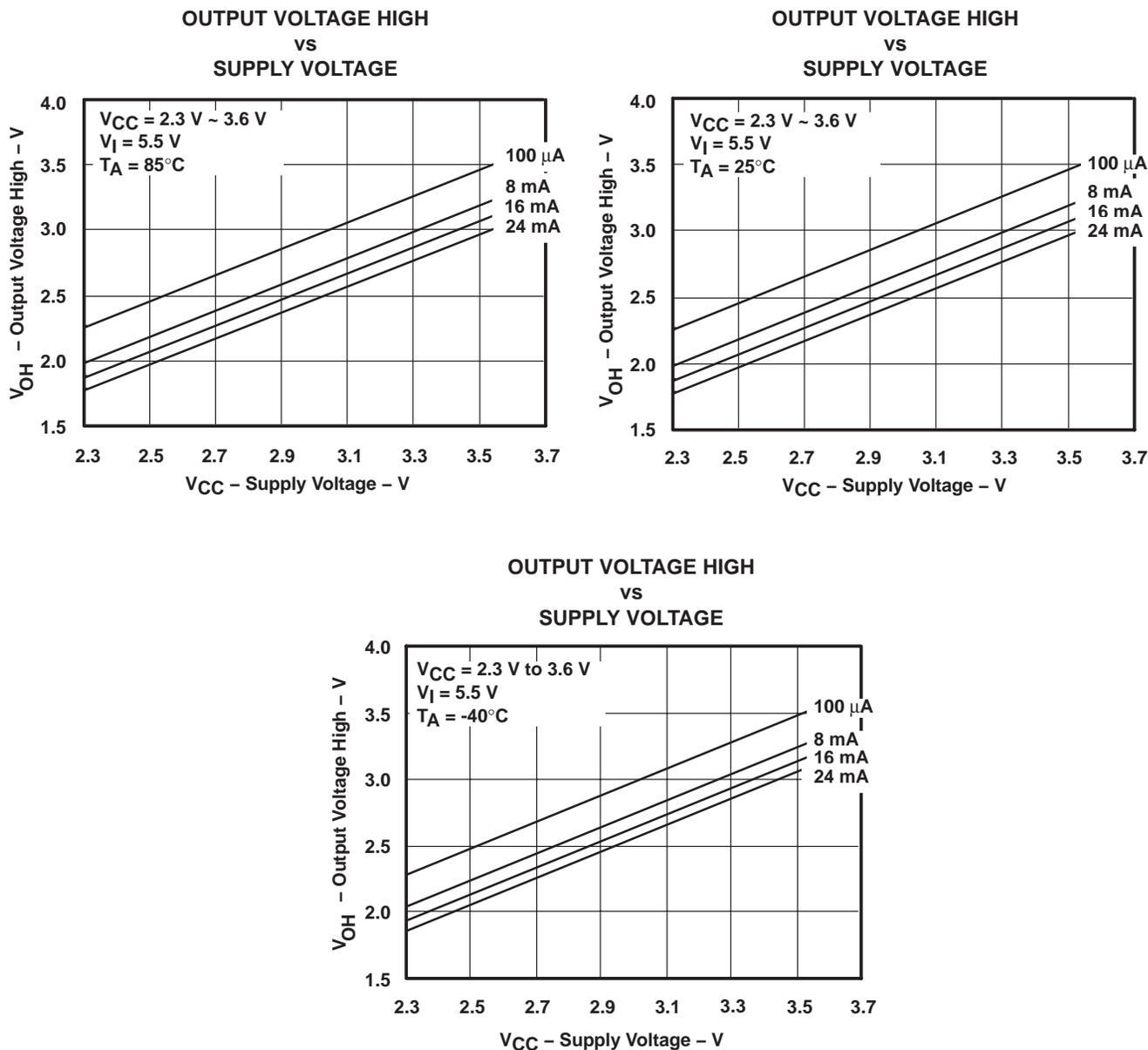


Figure 4. V_{OH} Values

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
74CB3T3384DBQRE4	ACTIVE	SSOP/QSOP	DBQ	24	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
74CB3T3384DBQRG4	ACTIVE	SSOP/QSOP	DBQ	24	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN74CB3T3384DBQR	ACTIVE	SSOP/QSOP	DBQ	24	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN74CB3T3384DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384DWE4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384DWG4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384DWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384DWRE4	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384DWRG4	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384PW	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384PWE4	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384PWG4	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384PWR	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384PWRE4	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74CB3T3384PWRG4	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

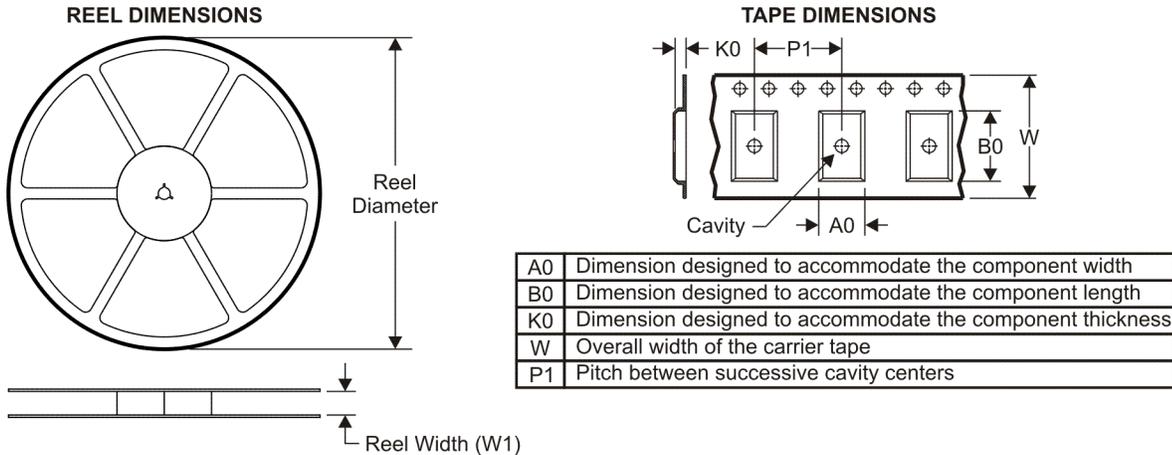
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

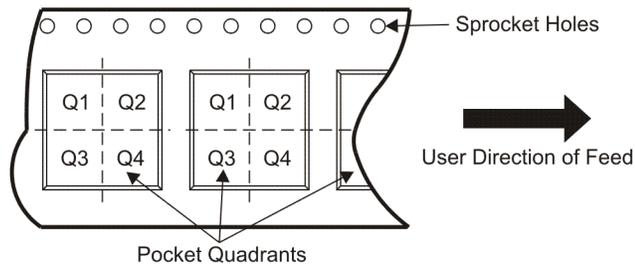
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TAPE AND REEL INFORMATION



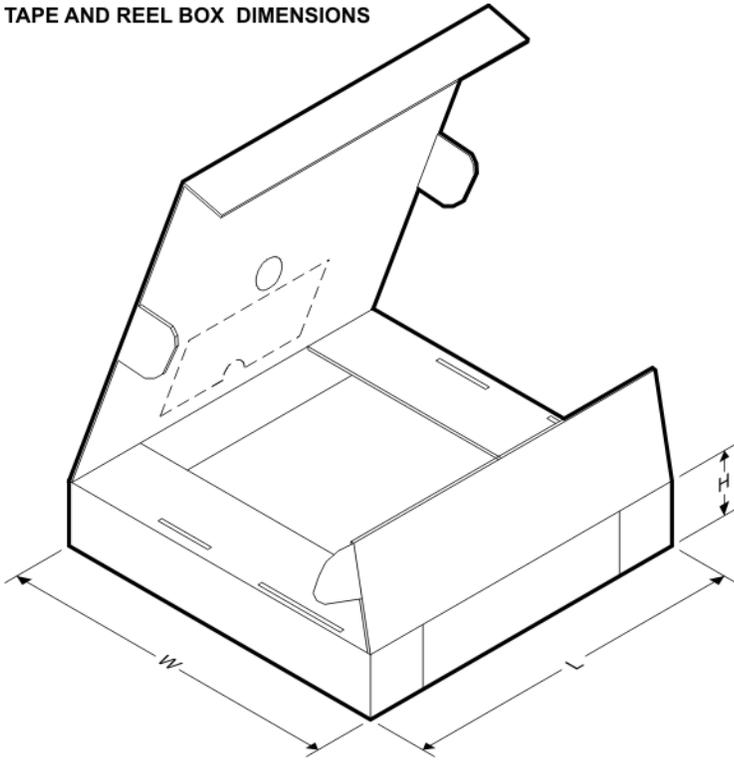
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN74CB3T3384DBQR	SSOP/QSOP	DBQ	24	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
SN74CB3T3384DWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1
SN74CB3T3384PWR	TSSOP	PW	24	2000	330.0	16.4	6.95	8.3	1.6	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS

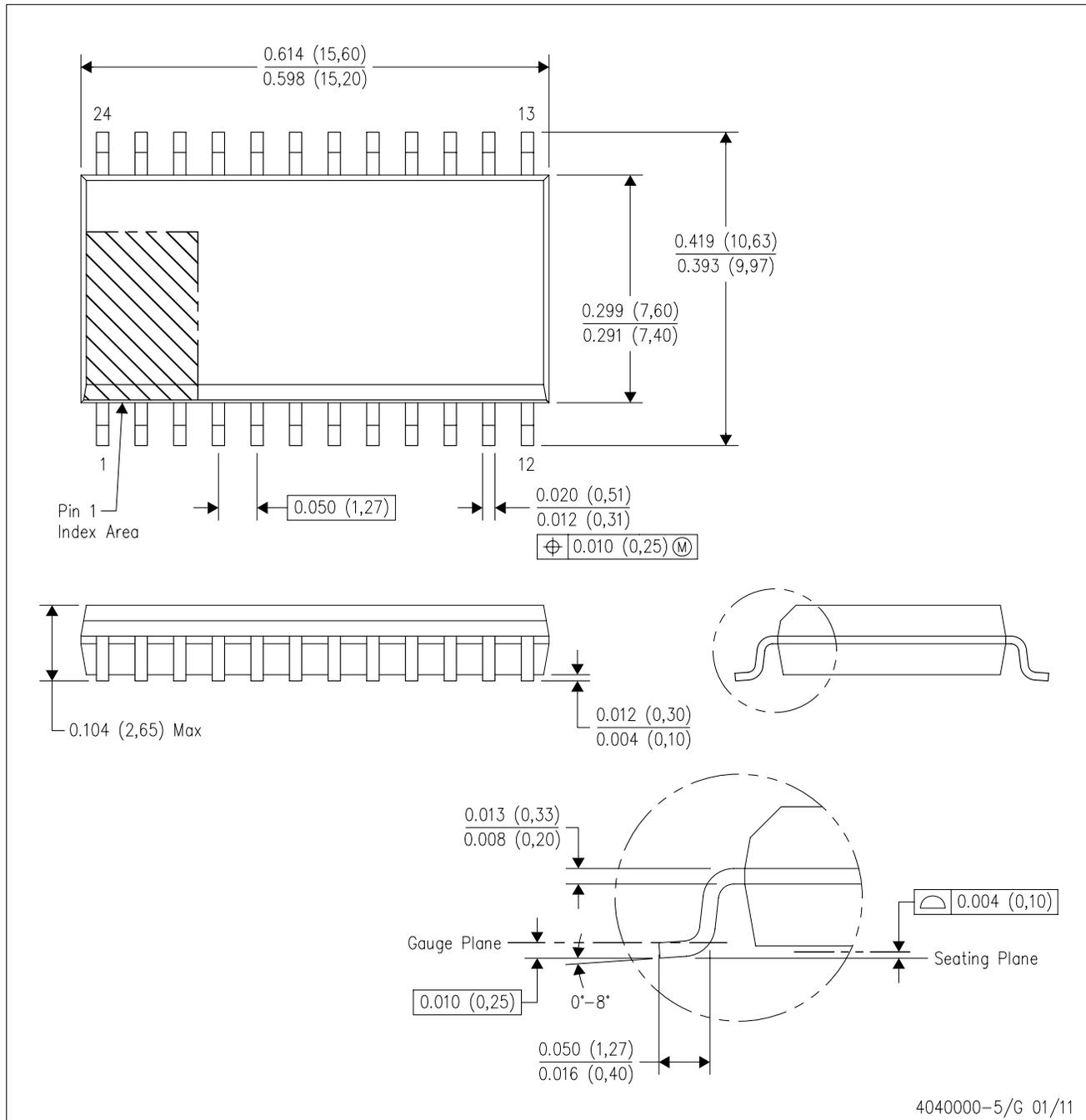


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74CB3T3384DBQR	SSOP/QSOP	DBQ	24	2500	346.0	346.0	33.0
SN74CB3T3384DWR	SOIC	DW	24	2000	346.0	346.0	41.0
SN74CB3T3384PWR	TSSOP	PW	24	2000	346.0	346.0	33.0

DW (R-PDSO-G24)

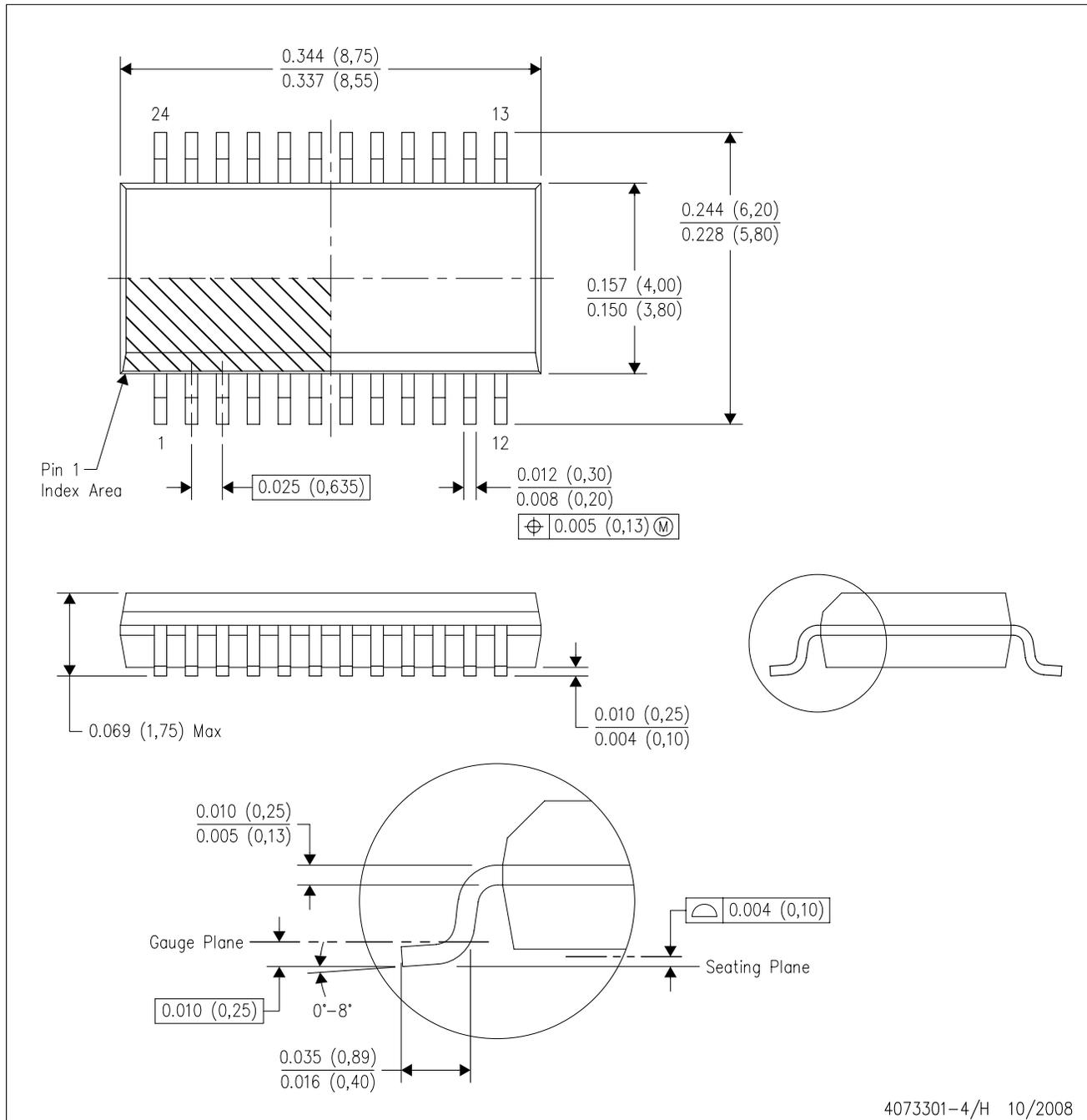
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MS-013 variation AD.

DBQ (R-PDSO-G24)

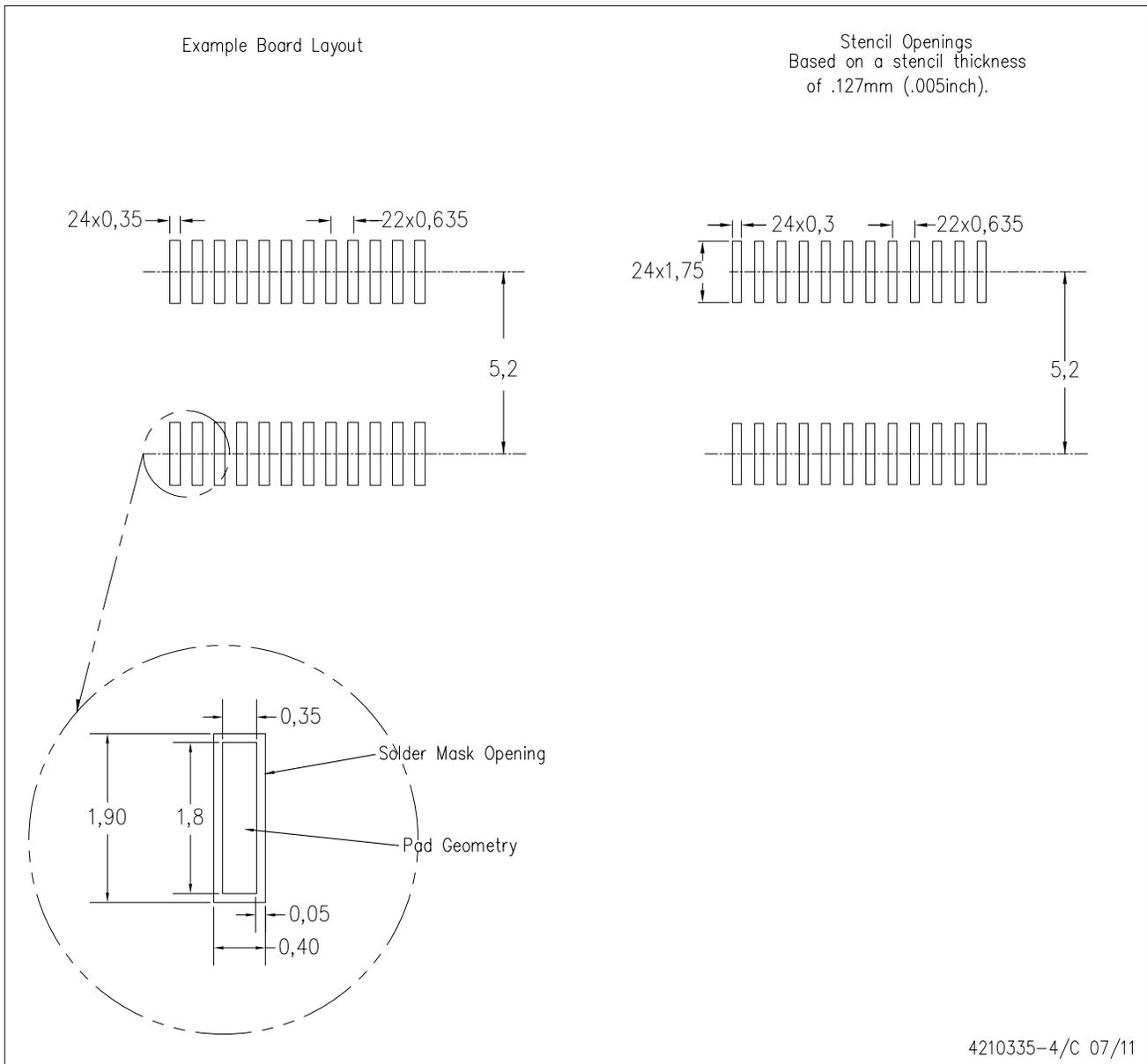
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15) per side.
 - D. Falls within JEDEC MO-137 variation AE.

DBQ (R-PDSO-G24)

PLASTIC SMALL OUTLINE PACKAGE

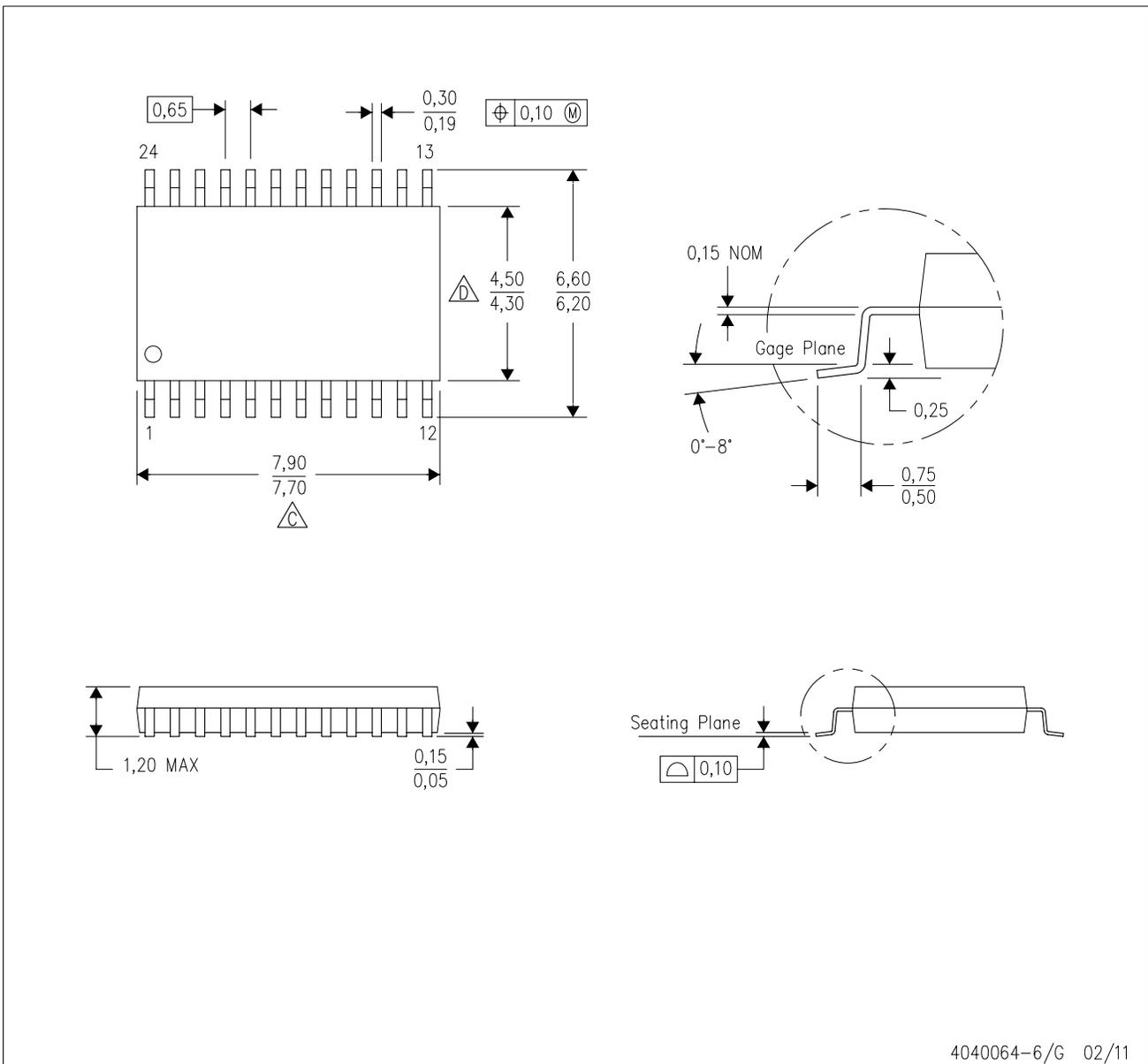


- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - D. Publication IPC-7351 is recommended for alternate designs.
 - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

MECHANICAL DATA

PW (R-PDSO-G24)

PLASTIC SMALL OUTLINE

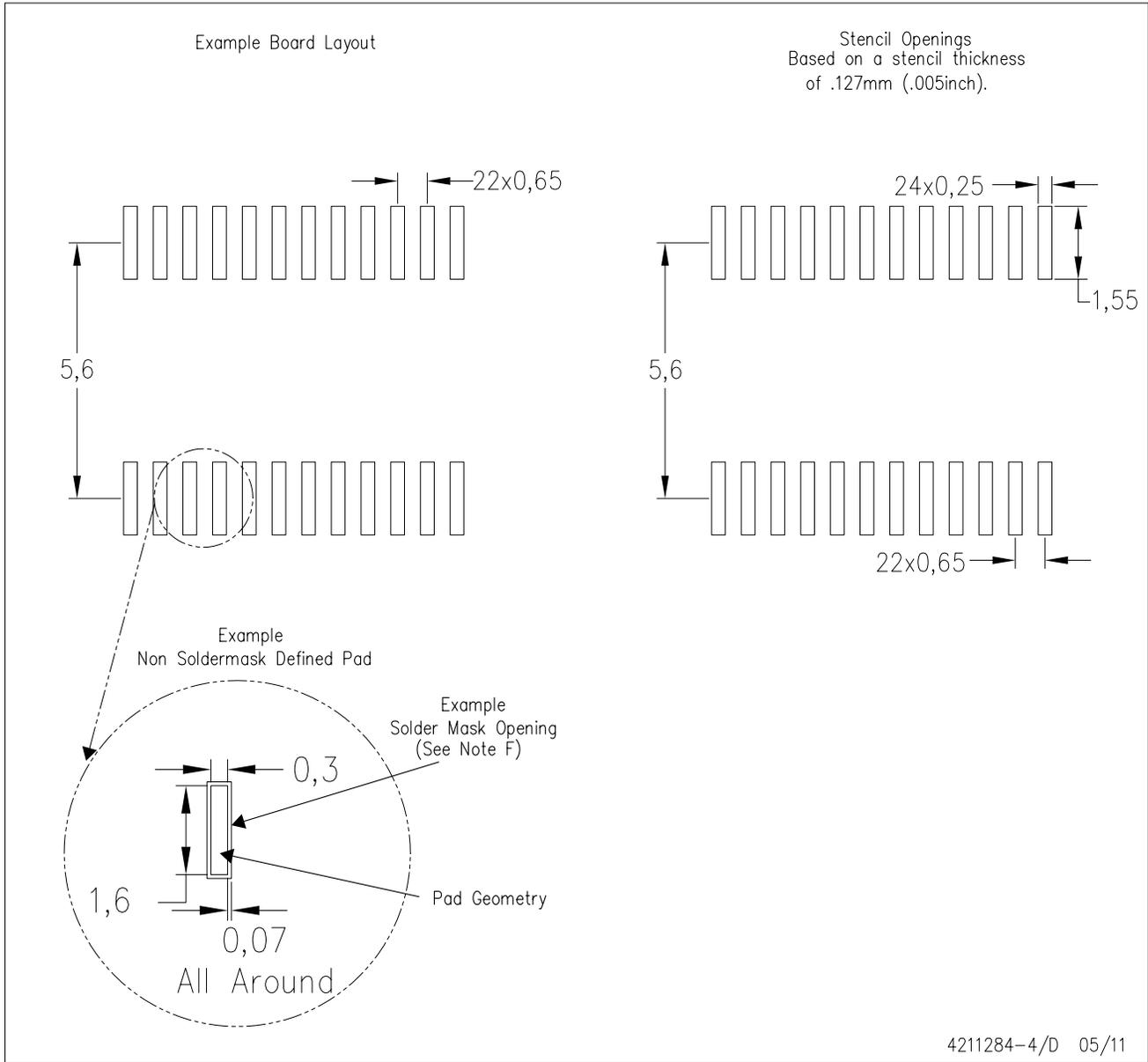


4040064-6/G 02/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 -  C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
 -  D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

PW (R-PDSO-G24)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate design.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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