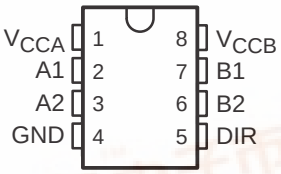
DUAL-BIT DUAL-SUPPLY BUS TRANSCEIVER WITH CONFIGURABLE VOLTAGE TRANSLATION AND 3-STATE OUTPUTS

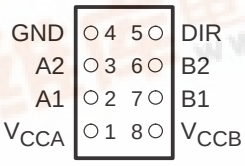
SCES516E – DECEMBER 2003 – REVISED MAY 2004

- Available in the Texas Instruments NanoStar™ and NanoFree™ Packages
- Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.65-V to 5.5-V Power-Supply Range
- V_{CC} Isolation Feature – If Either V_{CC} Input Is at GND, Both Ports Are in the High-Impedance State
- DIR Input Circuit Referenced to V_{CCA}
- Low Power Consumption, 10-μA Max I_{CC}
- ±24-mA Output Drive at 3.3 V
- I_{off} Supports Partial-Power-Down Mode Operation
- Max Data Rates
  - 420 Mbps (3.3-V to 5-V Translation)
  - 210 Mbps (Translate to 3.3 V)
  - 140 Mbps (Translate to 2.5 V)
  - 75 Mbps (Translate to 1.8 V)
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)

DCT OR DCU PACKAGE
(TOP VIEW)



YEP OR YZP PACKAGE
(BOTTOM VIEW)



description/ordering information

This dual-bit noninverting bus transceiver uses two separate configurable power-supply rails. The A port is designed to track V_{CCA}. V_{CCA} accepts any supply voltage from 1.65 V to 5.5 V. The B port is designed to track V_{CCB}. V_{CCB} accepts any supply voltage from 1.65 V to 5.5 V. This allows for universal low-voltage bidirectional translation between any of the 1.8-V, 2.5-V, 3.3-V, and 5-V voltage nodes.

The SN74LVC2T45 is designed for asynchronous communication between data buses. The device transmits data from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING‡
−40°C to 85°C	NanoStar™ – WCSP (DSBGA) 0.23-mm Large Bump – YEP	Reel of 3000	SN74LVC2T45YEPR	_ _ _TB_
	NanoFree™ – WCSP (DSBGA) 0.23-mm Large Bump – YZP (Pb-free)		SN74LVC2T45YZPR	
	SSOP – DCT	Reel of 3000	SN74LVC2T45DCTR	CT2_ _ _
		Reel of 250	SN74LVC2T45DCTT	
	VSSOP – DCU	Reel of 3000	SN74LVC2T45DCUR	CT2_
		Reel of 250	SN74LVC2T45DCUT	

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

‡ DCT: The actual top-side marking has three additional characters that designate the year, month, and assembly/test site.
DCU: The actual top-side marking has one additional character that designates the assembly/test site.
YEP/YZP: The actual top-side marking has three preceding characters to denote year, month, and sequence code, and one following character to designate the assembly/test site. Pin 1 identifier indicates solder-bump composition (1 = SnPb, ● = Pb-free).

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

NanoStar and NanoFree are trademarks of Texas Instruments.

description/ordering information (continued)

The SN74LVC2T45 is designed so that the DIR input circuit is supplied by V_{CCA}.

This device is fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

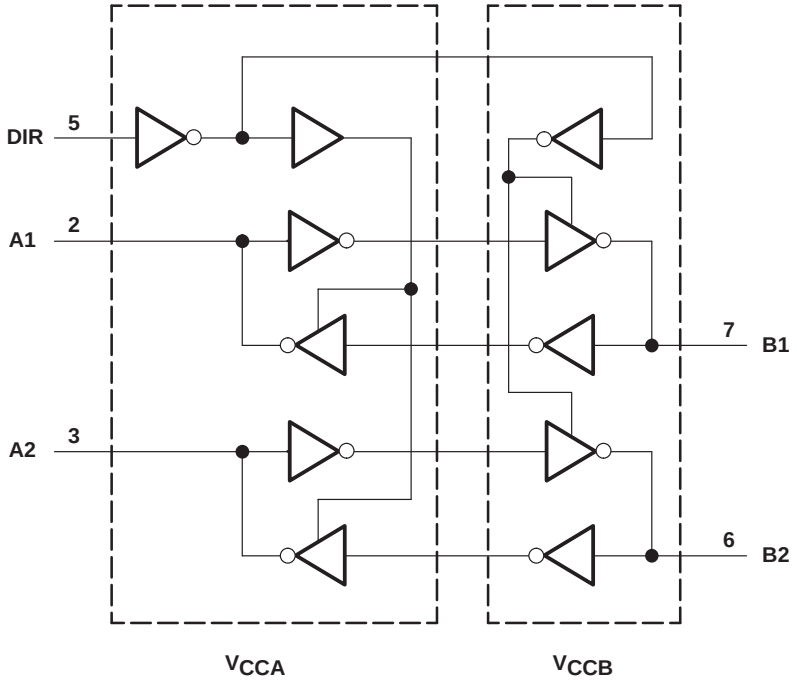
The V_{CC} isolation feature ensures that if either V_{CC} input is at GND, both ports are in the high-impedance state.

NanoStar™ and NanoFree™ package technology is a major breakthrough in IC packaging concepts, using the die as the package.

FUNCTION TABLE
(each transceiver)

INPUT DIR	OPERATION
L	B data to A bus
H	A data to B bus

logic diagram (positive logic)



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

Supply voltage range, V_{CCA} and V_{CCB}	−0.5 V to 6.5 V
Input voltage range, V_I (see Note 1)	−0.5 V to 6.5 V
Voltage range applied to any output in the high-impedance or power-off state, V_O (see Note 1)	−0.5 V to 6.5 V
Voltage range applied to any output in the high or low state, V_O (see Notes 1 and 2): A port	−0.5 V to V_{CCA} + 0.5V
B port	−0.5 V to V_{CCB} + 0.5V
Input clamp current, I_{IK} (V_I < 0)	−50 mA
Output clamp current, I_{OK} (V_O < 0)	−50 mA
Continuous output current, I_O	±50 mA
Continuous current through V_{CC} or GND	±100 mA
Package thermal impedance, θ_{JA} (see Note 3): DCT package	220°C/W
DCU package	227°C/W
YEP/YZP package	102°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. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. The value of V_{CC} is provided in the recommended operating conditions table.
3. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Notes 4 through 6)

			V_{CCI}	V_{CCO}	MIN	MAX	UNIT
V_{CCA}	Supply voltage				1.65	5.5	V
V_{CCB}					1.65	5.5	
V_{IH}	High-level input voltage	Data inputs (see Note 7)	1.65 V to 1.95 V		$V_{CCI} \times 0.65$		V
			2.3 V to 2.7 V		1.7		
			3 V to 3.6 V		2		
			4.5 V to 5.5 V		$V_{CCI} \times 0.7$		
V_{IL}	Low-level input voltage	Data inputs (see Note 7)	1.65 V to 1.95 V			$V_{CCI} \times 0.35$	V
			2.3 V to 2.7 V			0.7	
			3 V to 3.6 V			0.8	
			4.5 V to 5.5 V			$V_{CCI} \times 0.3$	
V_{IH}	High-level input voltage	DIR (Referenced to V_{CCA}) (see Note 8)	1.65 V to 1.95 V		$V_{CCA} \times 0.65$		V
			2.3 V to 2.7 V		1.7		
			3 V to 3.6 V		2		
			4.5 V to 5.5 V		$V_{CCA} \times 0.7$		
V_{IL}	Low-level input voltage	DIR (Referenced to V_{CCA}) (see Note 8)	1.65 V to 1.95 V			$V_{CCA} \times 0.35$	V
			2.3 V to 2.7 V			0.7	
			3 V to 3.6 V			0.8	
			4.5 V to 5.5 V			$V_{CCA} \times 0.3$	
V_I	Input voltage				0	5.5	V
V_O	Output voltage				0	V_{CCO}	V
I_{OH}	High-level output current			1.65 V to 1.95 V		−4	mA
				2.3 V to 2.7 V		−8	
				3 V to 3.6 V		−24	
				4.5 V to 5.5 V		−32	
I_{OL}	Low-level output current			1.65 V to 1.95 V		4	mA
				2.3 V to 2.7 V		8	
				3 V to 3.6 V		24	
				4.5 V to 5.5 V		32	
$\Delta t/\Delta v$	Input transition rise or fall rate	Data inputs	1.65 V to 1.95 V			20	ns/V
			2.3 V to 2.7 V			20	
			3 V to 3.6 V			10	
			4.5 V to 5.5 V			5	
		Control input	1.65 V to 5.5 V			5	
T_A	Operating free-air temperature				−40	85	°C

NOTES: 4. V_{CCI} is the V_{CC} associated with the data input port.
5. V_{CCO} is the V_{CC} associated with the output port.
6. All unused data inputs of the device must be held at V_{CCI} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.
7. For V_{CCI} values not specified in the data sheet, $V_{IH(min)} = V_{CCI} \times 0.7$ V, $V_{IL(max)} = V_{CCI} \times 0.3$ V.
8. For V_{CCI} values not specified in the data sheet, $V_{IH(min)} = V_{CCA} \times 0.7$ V, $V_{IL(max)} = V_{CCA} \times 0.3$ V.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Notes 9 and 10)

PARAMETER		TEST CONDITIONS		V_{CCA}	V_{CCB}	T_A = 25°C			−40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
V_{OH}		I_{OH} = −100 μA, $V_I = V_{IH}$		1.65 V to 4.5 V	1.65 V to 4.5 V				V_{CCO}−0.1		V
		I_{OH} = −4 mA, $V_I = V_{IH}$		1.65V	1.65 V				1.2		
		I_{OH} = −8 mA, $V_I = V_{IH}$		2.3 V	2.3 V				1.9		
		I_{OH} = −24 mA, $V_I = V_{IH}$		3 V	3 V				2.4		
		I_{OH} = −32 mA, $V_I = V_{IH}$		4.5 V	4.5 V				3.8		
V_{OL}		I_{OL} = 100 μA, $V_I = V_{IL}$		1.65 V to 4.5 V	1.65 V to 4.5 V					0.1	V
		I_{OL} = 4 mA, $V_I = V_{IL}$		1.65 V	1.65 V					0.45	
		I_{OL} = 8 mA, $V_I = V_{IL}$		2.3 V	2.3 V					0.3	
		I_{OL} = 24 mA, $V_I = V_{IL}$		3 V	3 V					0.55	
		I_{OL} = 32 mA, $V_I = V_{IL}$		4.5 V	4.5 V					0.55	
I_I	DIR input	$V_I = V_{CCA}$ or GND		1.65 V to 5.5 V	1.65 V to 5.5 V			±1		±2	μA
I_{off}	A port	V_I or V_O = 0 to 5.5 V		0 V	0 to 5.5 V			±1		±2	μA
	B port			0 to 5.5 V	0 V			±1		±2	
I_{OZ}	A or B ports	$V_O = V_{CCO}$ or GND		1.65 V to 5.5 V	1.65 V to 5.5 V			±1		±2	μA
I_{CCA}		$V_I = V_{CCI}$ or GND	I_O = 0	1.65 V to 5.5 V	1.65 V to 5.5 V					3	μA
				5 V	0 V					2	
				0 V	5 V					0	
I_{CCB}		$V_I = V_{CCI}$ or GND	I_O = 0	1.65 V to 5.5 V	1.65 V to 5.5 V					3	μA
				5 V	0 V					0	
				0 V	5 V					2	
$I_{CCA} + I_{CCB}$		$V_I = V_{CCI}$ or GND	I_O = 0	1.65 V to 5.5 V	1.65 V to 5.5 V					4	μA
ΔI_{CCA}	A port	One A port at V_{CCA} − 0.6 V, DIR at V_{CCA}, B port = OPEN		3 V to 5.5 V	3 V to 5.5 V					50	μA
	DIR	DIR at V_{CCA} − 0.6 V, B port = OPEN, A port at V_{CCA} or GND								50	
ΔI_{CCB}	B port	One B port at V_{CCB} − 0.6 V, DIR at GND, A port = OPEN		3 V to 5.5 V	3 V to 5.5 V					50	μA
C_i	DIR input	$V_I = V_{CCA}$ or GND		3.3 V	3.3 V		2.5				pF
C_{io}	A or B ports	$V_O = V_{CCA/B}$ or GND		3.3 V	3.3 V		6				pF

NOTES: 9. V_{CCO} is the V_{CC} associated with the output port.
10. V_{CCI} is the V_{CC} associated with the input port.

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 1.8 V ± 0.15 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.8 V ± 0.15 V		V_{CCB} = 2.5 V ± 0.2 V		V_{CCB} = 3.3 V ± 0.3 V		V_{CCB} = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B	3	17.7	2.2	10.3	1.7	8.3	1.4	7.2	ns
t_{PHL}			2.8	14.3	2.2	8.5	1.8	7.1	1.7	7	
t_{PLH}	B	A	3	17.7	2.3	16	2.1	15.5	1.9	15.1	ns
t_{PHL}			2.8	14.3	2.1	12.9	2	12.6	1.8	12.2	
t_{PHZ}	DIR	A	10.6	30.9	10.3	30.5	10.5	30.5	10.7	29.3	ns
t_{PLZ}			7.3	19.7	7.5	19.6	7.5	19.5	7	19.4	
t_{PHZ}	DIR	B	10	27.9	8.4	14.9	6.5	11.3	4.1	8.6	ns
t_{PLZ}			6.5	19.5	7.2	12.6	4.3	9.7	2.1	7.1	
t_{PZH}†	DIR	A		37.2		28.6		25.2		22.2	ns
t_{PZL}†				42.2		27.8		23.9		20.8	
t_{PZH}†	DIR	B		37.4		29.9		27.8		26.6	ns
t_{PZL}†				45.2		39		37.6		36.3	

† The enable time is a calculated value, derived using the formula shown in the section entitled *enable times* on page 16.

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.8 V ± 0.15 V		V_{CCB} = 2.5 V ± 0.2 V		V_{CCB} = 3.3 V ± 0.3 V		V_{CCB} = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B	2.3	16	1.5	8.5	1.3	6.4	1.1	5.1	ns
t_{PHL}			2.1	12.9	1.4	7.5	1.3	5.4	0.9	4.6	
t_{PLH}	B	A	2.2	10.3	1.5	8.5	1.4	8	1	7.5	ns
t_{PHL}			2.2	8.5	1.4	7.5	1.3	7	0.9	6.2	
t_{PHZ}	DIR	A	6.6	17.1	7.1	16.8	6.8	16.8	5.2	16.5	ns
t_{PLZ}			5.3	12.6	5.2	12.5	4.9	12.3	4.8	12.3	
t_{PHZ}	DIR	B	10.7	27.9	8.1	13.9	5.8	10.5	3.5	7.6	ns
t_{PLZ}			7.8	18.9	6.2	11.2	3.6	8.9	1.4	6.2	
t_{PZH}†	DIR	A		29.2		19.7		16.9		13.7	ns
t_{PZL}†				36.4		21.4		17.5		13.8	
t_{PZH}†	DIR	B		28.6		21		18.7		17.4	ns
t_{PZL}†				30		24.3		22.2		21.1	

† The enable time is a calculated value, derived using the formula shown in the section entitled *enable times* on page 16.

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.8 V ± 0.15 V		V_{CCB} = 2.5 V ± 0.2 V		V_{CCB} = 3.3 V ± 0.3 V		V_{CCB} = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B	2.1	15.5	1.4	8	0.7	5.8	0.7	4.4	ns
t_{PHL}			2	12.6	1.3	7	0.8	5	0.7	4	
t_{PLH}	B	A	1.7	8.3	1.3	6.4	0.7	5.8	0.6	5.4	ns
t_{PHL}			1.8	7.1	1.3	5.4	0.8	5	0.7	4.5	
t_{PHZ}	DIR	A	5	10.9	5.1	10.8	5	10.8	5	10.4	ns
t_{PLZ}			3.4	8.4	3.7	8.4	3.9	8.1	3.3	7.8	
t_{PHZ}	DIR	B	11.2	27.3	8	13.7	5.8	10.4	2.9	7.4	ns
t_{PLZ}			9.4	17.7	5.6	11.3	4.3	8.3	1	5.6	
t_{PZH}†	DIR	A		26		17.7		14.1		11	ns
t_{PZL}†				34.4		19.1		15.4		11.9	
t_{PZH}†	DIR	B		23.9		16.4		13.9		12.2	ns
t_{PZL}†				23.5		17.8		15.8		14.4	

† The enable time is a calculated value, derived using the formula shown in the section entitled *enable times* on page 16.

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.8 V ± 0.15 V		V_{CCB} = 2.5 V ± 0.2 V		V_{CCB} = 3.3 V ± 0.3 V		V_{CCB} = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B	1.9	15.1	1	7.5	0.6	5.4	0.5	3.9	ns
t_{PHL}			1.8	12.2	0.9	6.2	0.7	4.5	0.5	3.5	
t_{PLH}	B	A	1.4	7.2	1	5.1	0.7	4.4	0.5	3.9	ns
t_{PHL}			1.7	7	0.9	4.6	0.7	4	0.5	3.5	
t_{PHZ}	DIR	A	2.9	8.2	2.9	7.9	2.8	7.9	2.2	7.8	ns
t_{PLZ}			1.4	6.9	1.3	6.7	0.7	6.7	0.7	6.6	
t_{PHZ}	DIR	B	11.2	26.1	7.2	13.9	5.8	10.1	1.3	7.3	ns
t_{PLZ}			8.4	16.9	5	11	4	7.7	1	5.6	
t_{PZH}†	DIR	A		24.1		16.1		12.1		9.5	ns
t_{PZL}†				33.1		18.5		14.1		10.8	
t_{PZH}†	DIR	B		22		14.2		12.1		10.5	ns
t_{PZL}†				20.4		14.1		12.4		11.3	

† The enable time is a calculated value, derived using the formula shown in the section entitled *enable times* on page 16.

operating characteristics, $T_A = 25°C$

PARAMETER		TEST CONDITIONS	$V_{CCA} = V_{CCB} = 1.8$ V	$V_{CCA} = V_{CCB} = 2.5$ V	$V_{CCA} = V_{CCB} = 3.3$ V	$V_{CCA} = V_{CCB} = 5$ V	UNIT
			TYP	TYP	TYP	TYP	
C_{pdA}†	A port input, B port output	$C_L = 0$, f = 10 MHz, $t_r = t_f$ = 1 ns	3	4	4	4	pF
	B port input, A port output		18	19	20	21	
C_{pdB}†	A port input, B port output		18	19	20	21	
	B port input, A port output		3	4	4	4	

† Power-dissipation capacitance per transceiver

power-up considerations

A proper power-up sequence always should be followed to avoid excessive supply current, bus contention, oscillations, or other anomalies. Take the following precautions to guard against such power-up problems:

1. Connect ground before any supply voltage is applied.
2. Power up V_{CCA}.
3. V_{CCB} can be ramped up along with or after V_{CCA}.

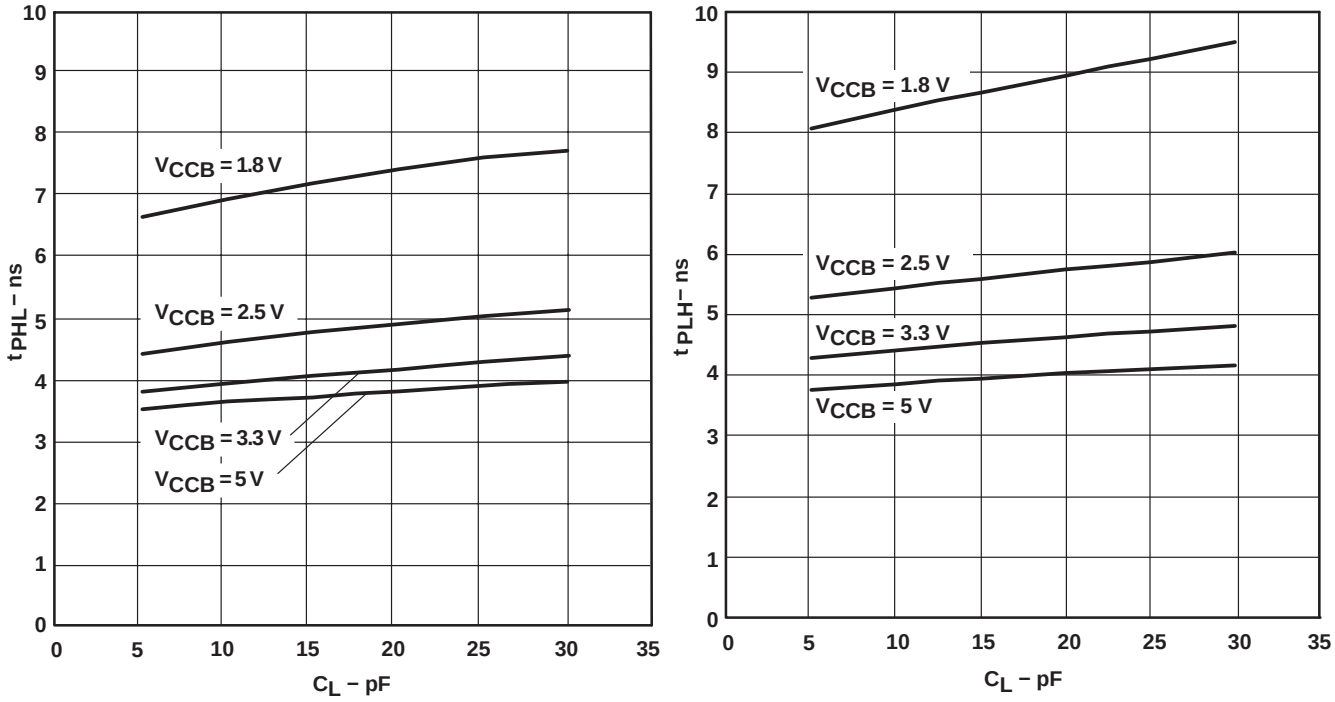
typical total static power consumption (I_{CCA} + I_{CCB})

Table 1

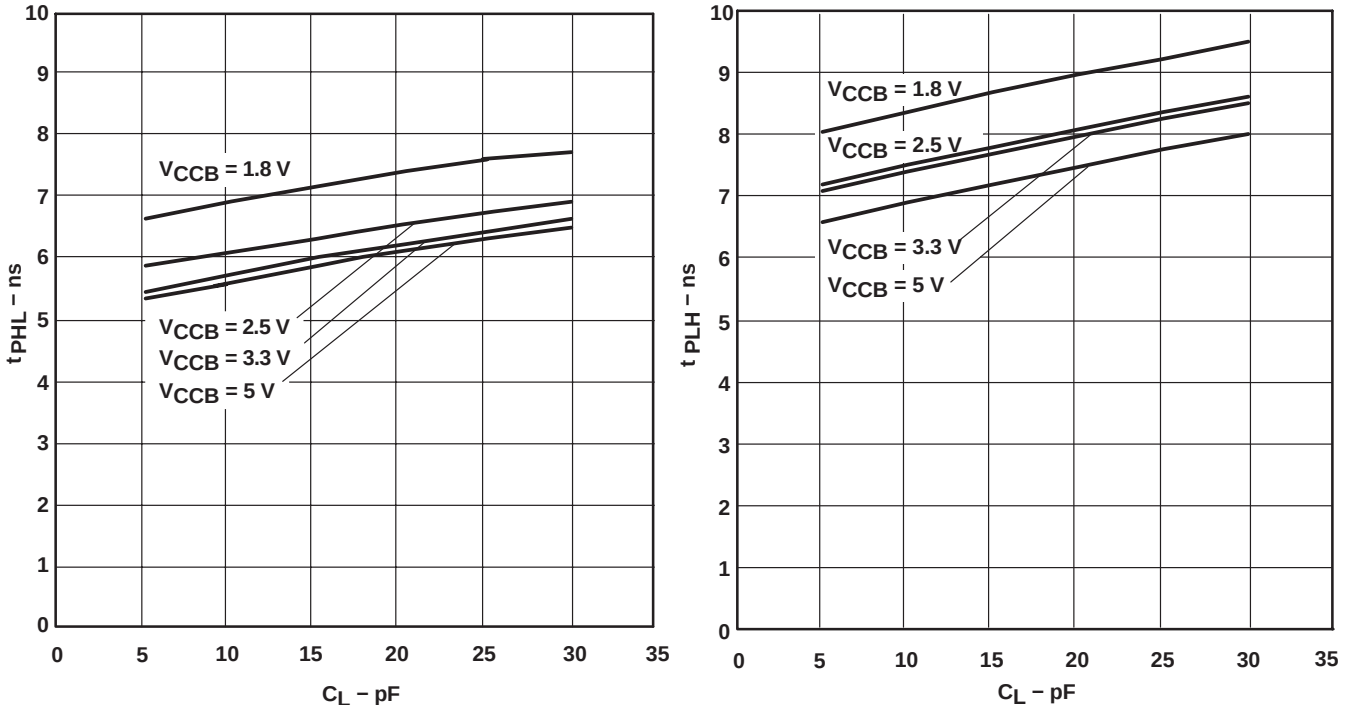
V_{CCB}	V_{CCA}					UNIT
	0 V	1.8 V	2.5 V	3.3 V	5 V	
0 V	0	<1	<1	<1	<1	μA
1.8 V	<1	<2	<2	<2	2	
2.5 V	<1	<2	<2	<2	<2	
3.3 V	<1	<2	<2	<2	<2	
5 V	<1	2	<2	<2	<2	

TYPICAL CHARACTERISTICS

TYPICAL PROPAGATION DELAY (A TO B) vs LOAD CAPACITANCE
$T_A = 25°C$, $V_{CCA} = 1.8$ V

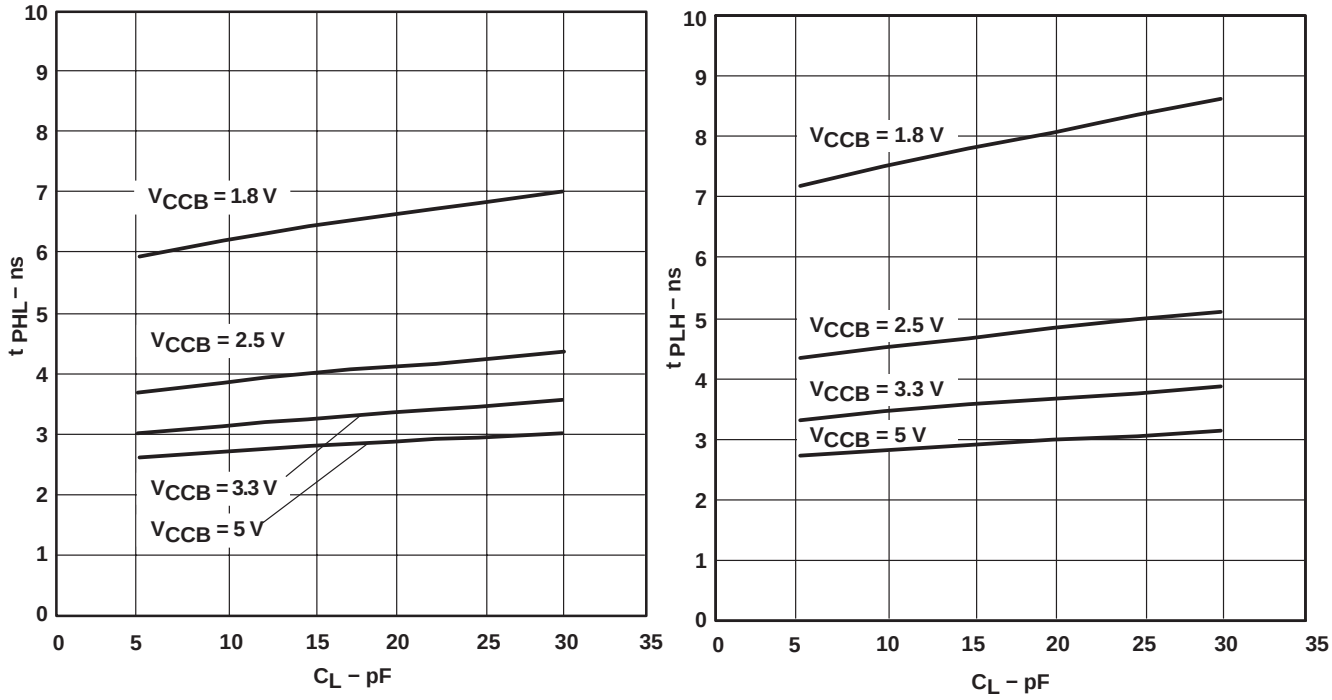


TYPICAL PROPAGATION DELAY (B TO A) vs LOAD CAPACITANCE
$T_A = 25°C$, $V_{CCA} = 1.8$ V

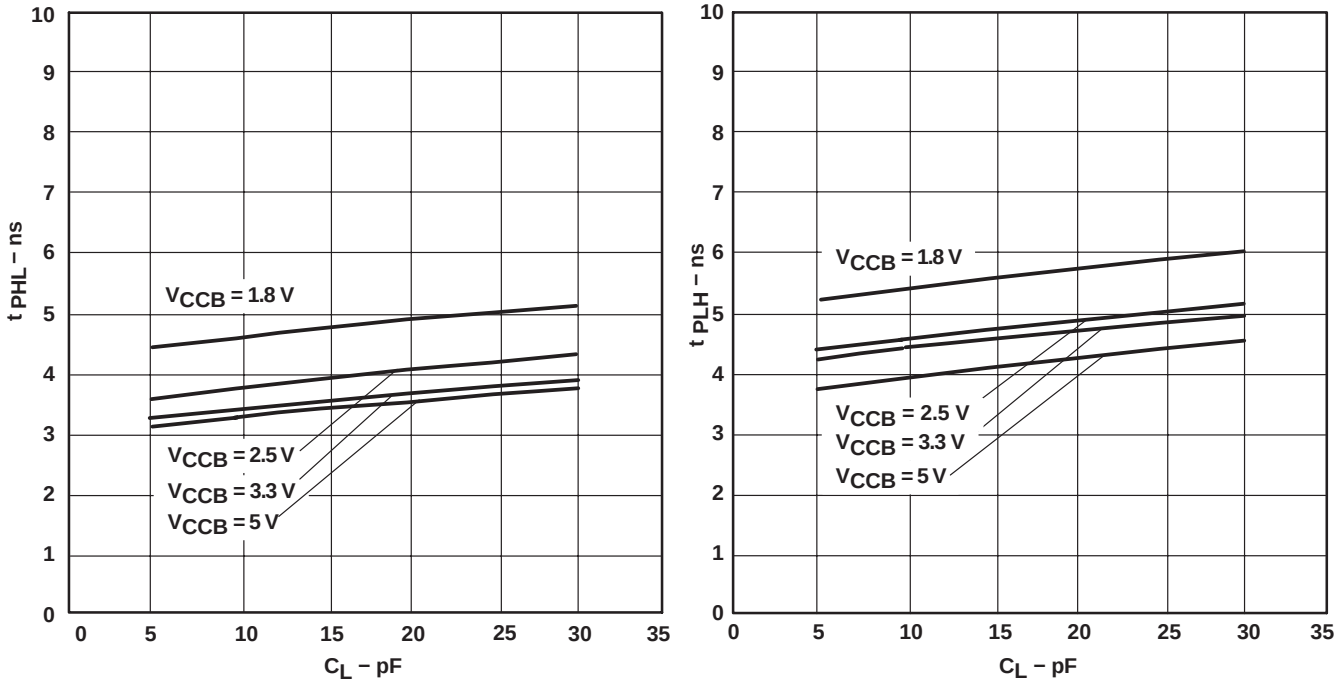


TYPICAL CHARACTERISTICS

TYPICAL PROPAGATION DELAY (A TO B) vs LOAD CAPACITANCE
$T_A = 25°C$, $V_{CCA} = 2.5$ V

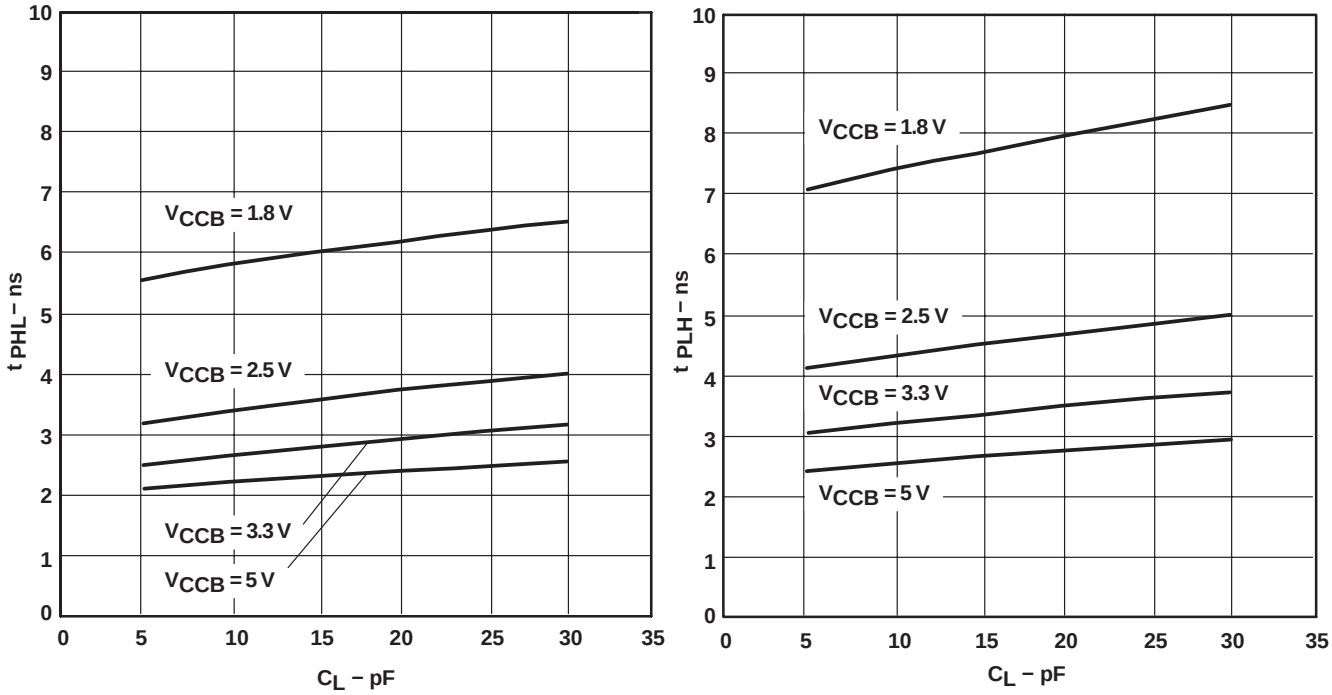


TYPICAL PROPAGATION DELAY (B TO A) vs LOAD CAPACITANCE
$T_A = 25°C$, $V_{CCA} = 2.5$ V

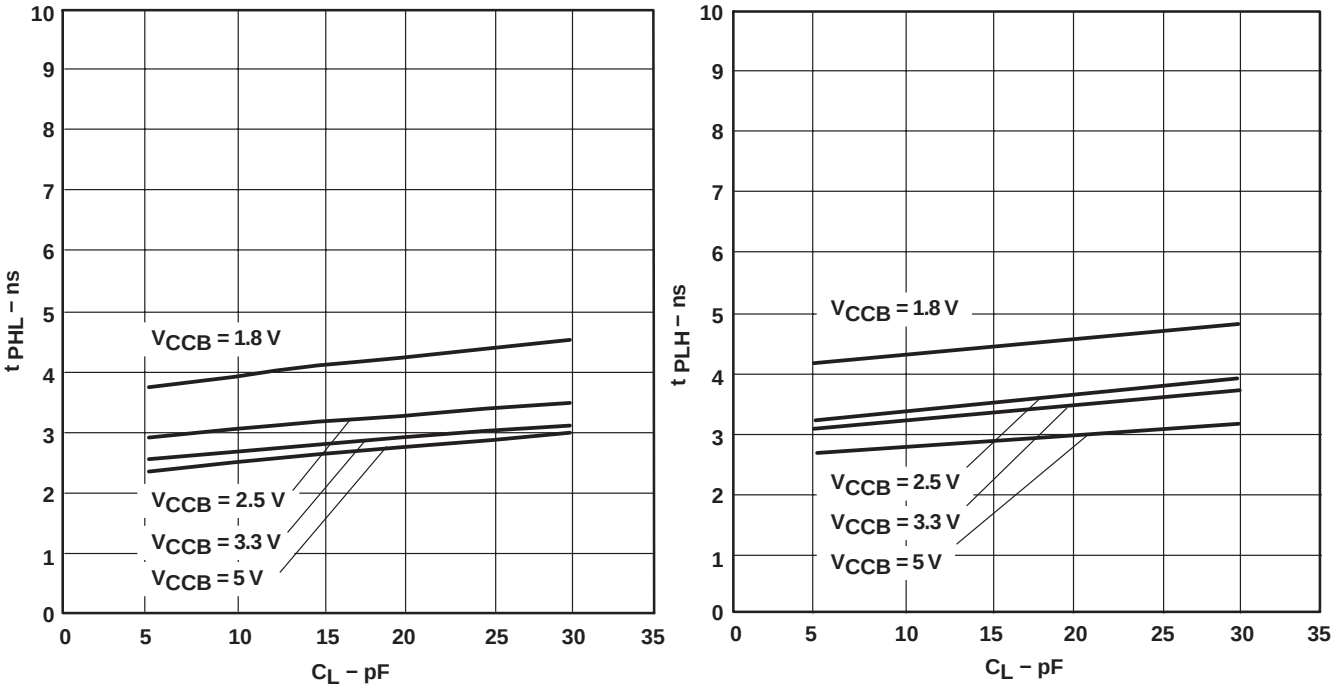


TYPICAL CHARACTERISTICS

TYPICAL PROPAGATION DELAY (A TO B) vs LOAD CAPACITANCE
$T_A = 25°C$, $V_{CCA} = 3.3$ V

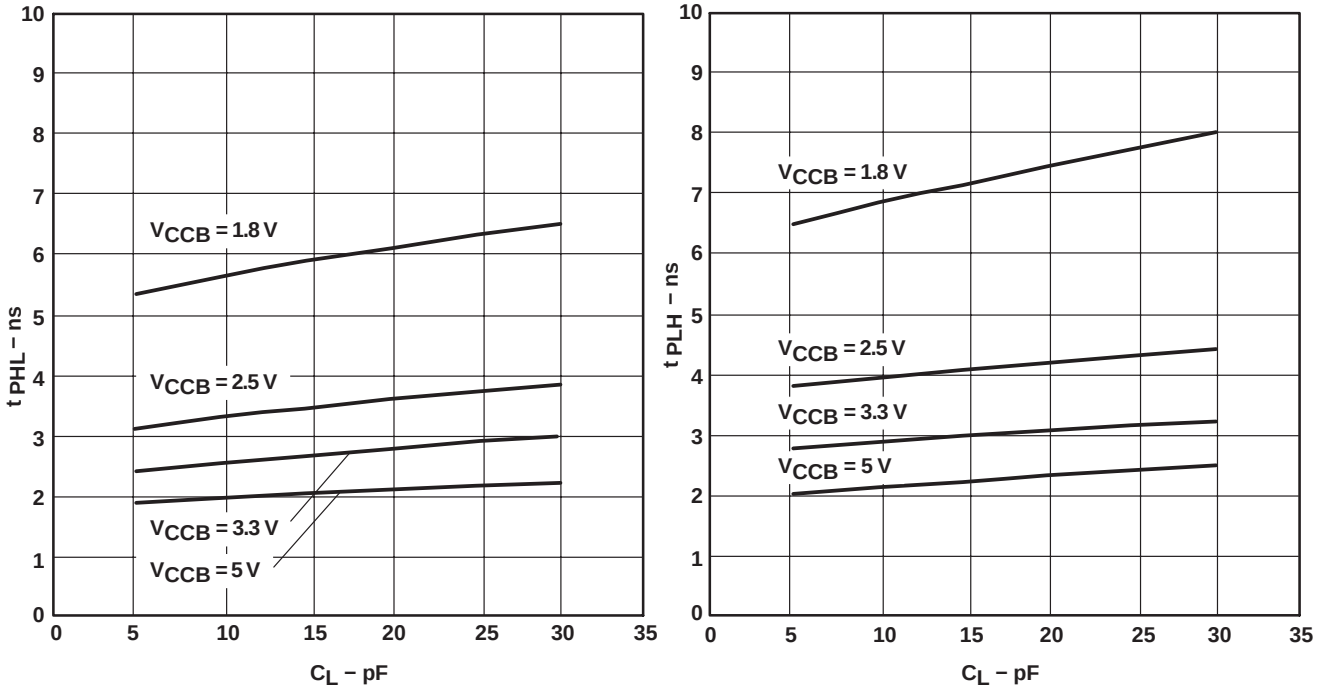


TYPICAL PROPAGATION DELAY (B TO A) vs LOAD CAPACITANCE
$T_A = 25°C$, $V_{CCA} = 3.3$ V

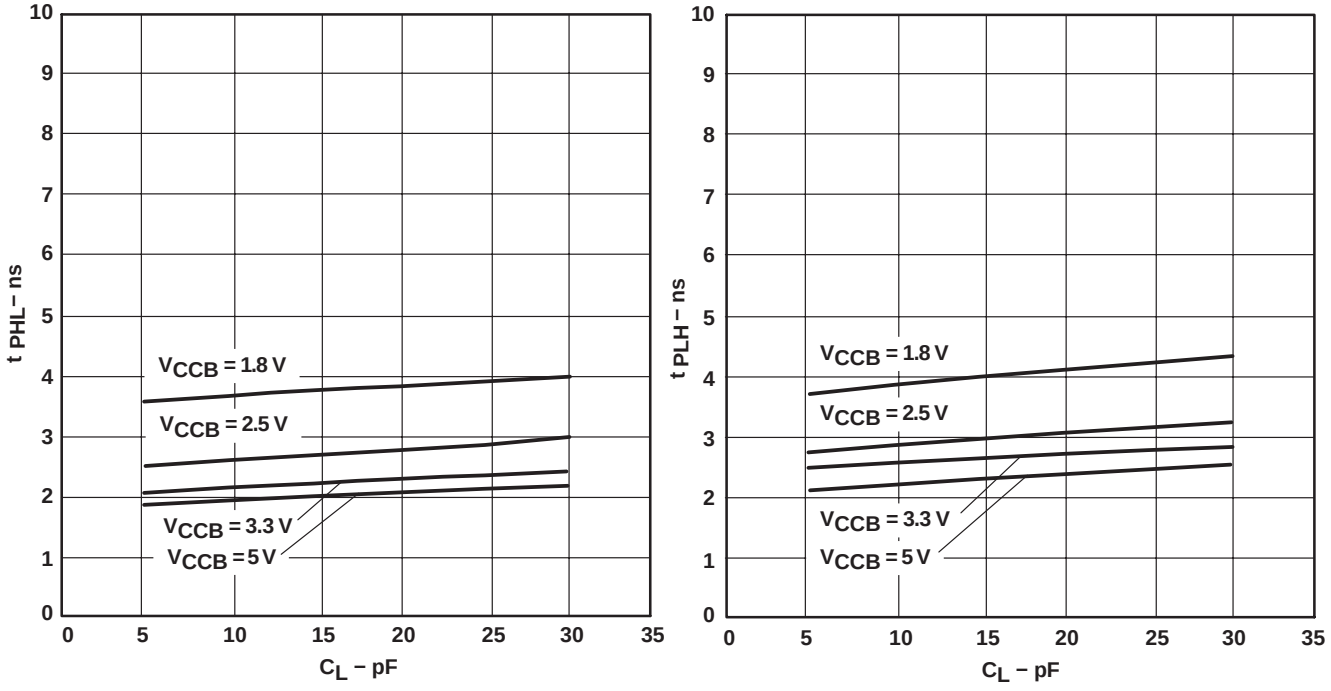


TYPICAL CHARACTERISTICS

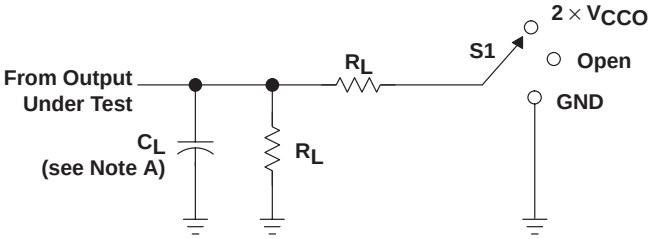
TYPICAL PROPAGATION DELAY (A to B) vs LOAD CAPACITANCE
$T_A = 25°C$, $V_{CCA} = 5$ V



TYPICAL PROPAGATION DELAY (B TO A) vs LOAD CAPACITANCE
$T_A = 25°C$, $V_{CCA} = 5$ V



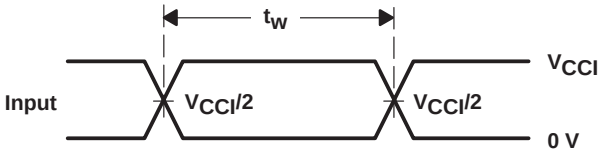
PARAMETER MEASUREMENT INFORMATION



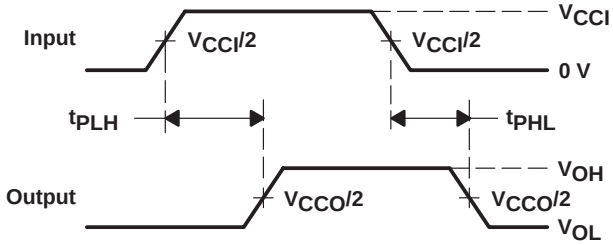
LOAD CIRCUIT

TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CCO}$
t_{PHZ}/t_{PZH}	GND

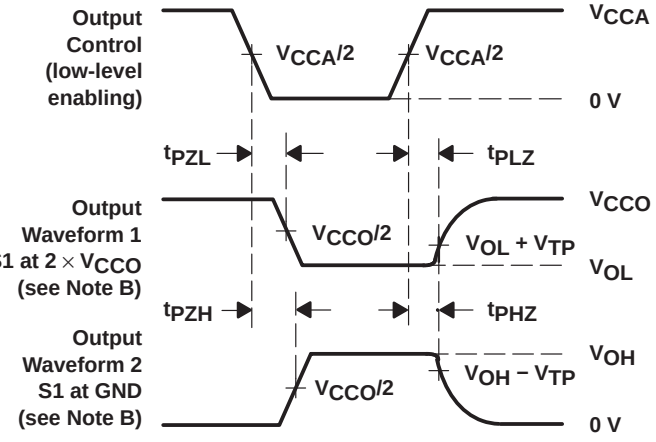
V_{CCO}	C_L	R_L	V_{TP}
1.8 V ± 0.15 V	15 pF	2 kΩ	0.15 V
2.5 V ± 0.2 V	15 pF	2 kΩ	0.15 V
3.3 V ± 0.3 V	15 pF	2 kΩ	0.3 V
5 V ± 0.5 V	15 pF	2 kΩ	0.3 V



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



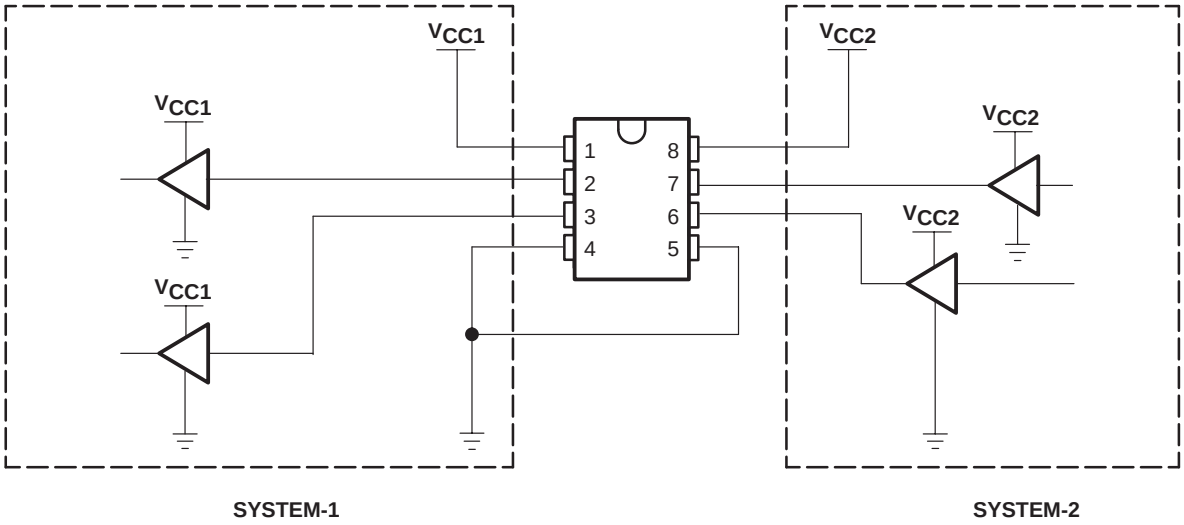
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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, dv/dt ≥ 1 V/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}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.
H. V_{CCI} is the V_{CC} associated with the input port.
I. V_{CCO} is the V_{CC} associated with the output port.
J. All parameters and waveforms are not applicable to all devices.

Figure 2. Load Circuit and Voltage Waveforms

APPLICATION INFORMATION

The following circuit is an example of the SN74LVC2T45 being used in a unidirectional logic level-shifting application.

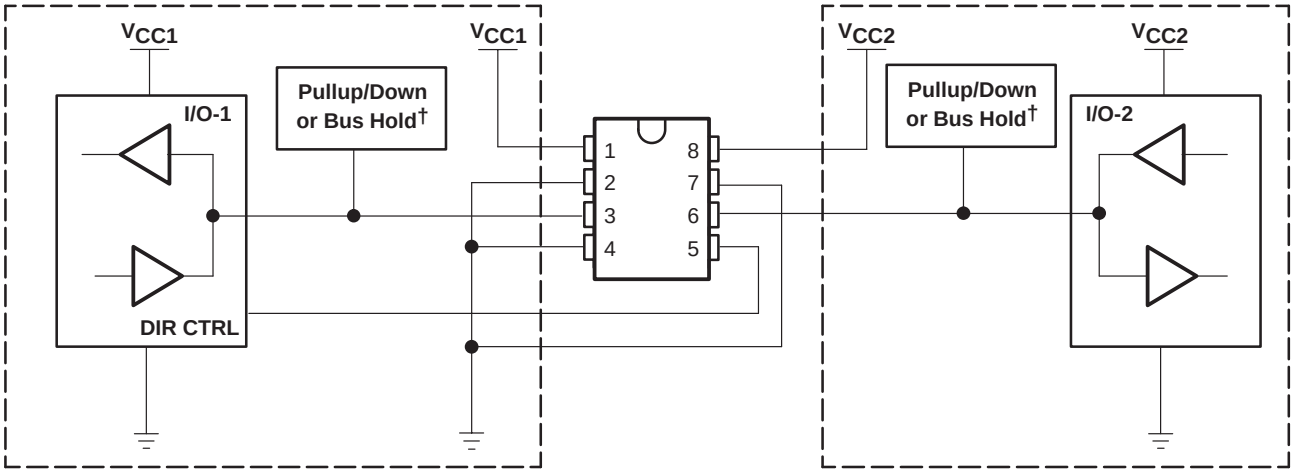


PIN	NAME	FUNCTION	DESCRIPTION
1	V_{CCA}	V_{CC1}	SYSTEM-1 supply voltage (1.65 V to 5.5 V)
2	A1	OUT1	Output level depends on V_{CC1} voltage.
3	A2	OUT2	Output level depends on V_{CC1} voltage.
4	GND	GND	Device GND
5	DIR	DIR	The GND (low-level) determines B port to A port direction.
6	B2	IN2	Input threshold value depends on V_{CC2} voltage.
7	B1	IN1	Input threshold value depends on V_{CC2} voltage.
8	V_{CCB}	V_{CC2}	SYSTEM-2 supply voltage (1.65 V to 5.5 V)

Figure 3. Unidirectional Logic Level-Shifting Application

APPLICATION INFORMATION

Figure 4 shows the SN74LVC2T45 being used in a bidirectional logic level-shifting application. Since the SN74LVC2T45 does not have an output enable (OE) pin, the system designer should take precautions to avoid bus contention between SYSTEM-1 and SYSTEM-2 when changing directions.



Following is a sequence that illustrates data transmission from SYSTEM-1 to SYSTEM-2 and then from SYSTEM-2 to SYSTEM-1.

STATE	DIR CTRL	I/O 1	I/O 2	DESCRIPTION
1	H	OUT	IN	SYSTEM-1 data to SYSTEM-2
2	H	HI-Z	HI-Z	SYSTEM-2 is getting ready to send data to SYSTEM-1. I/O-1 and I/O-2 are disabled. The bus-line state depends on pullup or pulldown.†
3	L	HI-Z	HI-Z	DIR bit is flipped. I/O-1 and I/O-2 still are disabled. The bus-line state depends on pullup or pulldown.†
4	L	OUT	IN	SYSTEM-2 data to SYSTEM-1

† SYSTEM-1 and SYSTEM-2 must use the same conditions, i.e., both pullup or both pulldown.

Figure 4. Bidirectional Logic Level-Shifting Application

enable times

Calculate the enable times for the SN74LVC2T45 using the following formulas:

1. t_{PZH} (DIR to A) = t_{PLZ} (DIR to B) + t_{PLH} (B to A)
2. t_{PZL} (DIR to A) = t_{PHZ} (DIR to B) + t_{PHL} (B to A)
3. t_{PZH} (DIR to B) = t_{PLZ} (DIR to A) + t_{PLH} (A to B)
4. t_{PZL} (DIR to B) = t_{PHZ} (DIR to A) + t_{PHL} (A to B)

In a bidirectional application, these enable times provide the maximum delay from the time the DIR bit is switched until an output is expected. For example, if the SN74LVC2T45 initially is transmitting from A to B, then the DIR bit is switched, the B port of the device must be disabled before presenting it with an input. After the B port has been disabled, an input signal applied to it appears on the corresponding A port after the specified propagation delay.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
SN74LVC2T45DCTR	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC2T45DCTRE4	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC2T45DCTT	ACTIVE	SM8	DCT	8	250	Pb-Free (RoHS)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC2T45DCUR	ACTIVE	US8	DCU	8	3000	Pb-Free (RoHS)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC2T45DCURE4	ACTIVE	US8	DCU	8	3000	Pb-Free (RoHS)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC2T45DCURG4	ACTIVE	US8	DCU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC2T45DCUT	ACTIVE	US8	DCU	8	250	Pb-Free (RoHS)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC2T45DCUTE4	ACTIVE	US8	DCU	8	250	Pb-Free (RoHS)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC2T45YEPR	ACTIVE	WCSP	YEP	8	3000	TBD	SNPB	Level-1-260C-UNLIM
SN74LVC2T45YZPR	ACTIVE	WCSP	YZP	8	3000	Pb-Free (RoHS)	SNAGCU	Level-1-260C-UNLIM

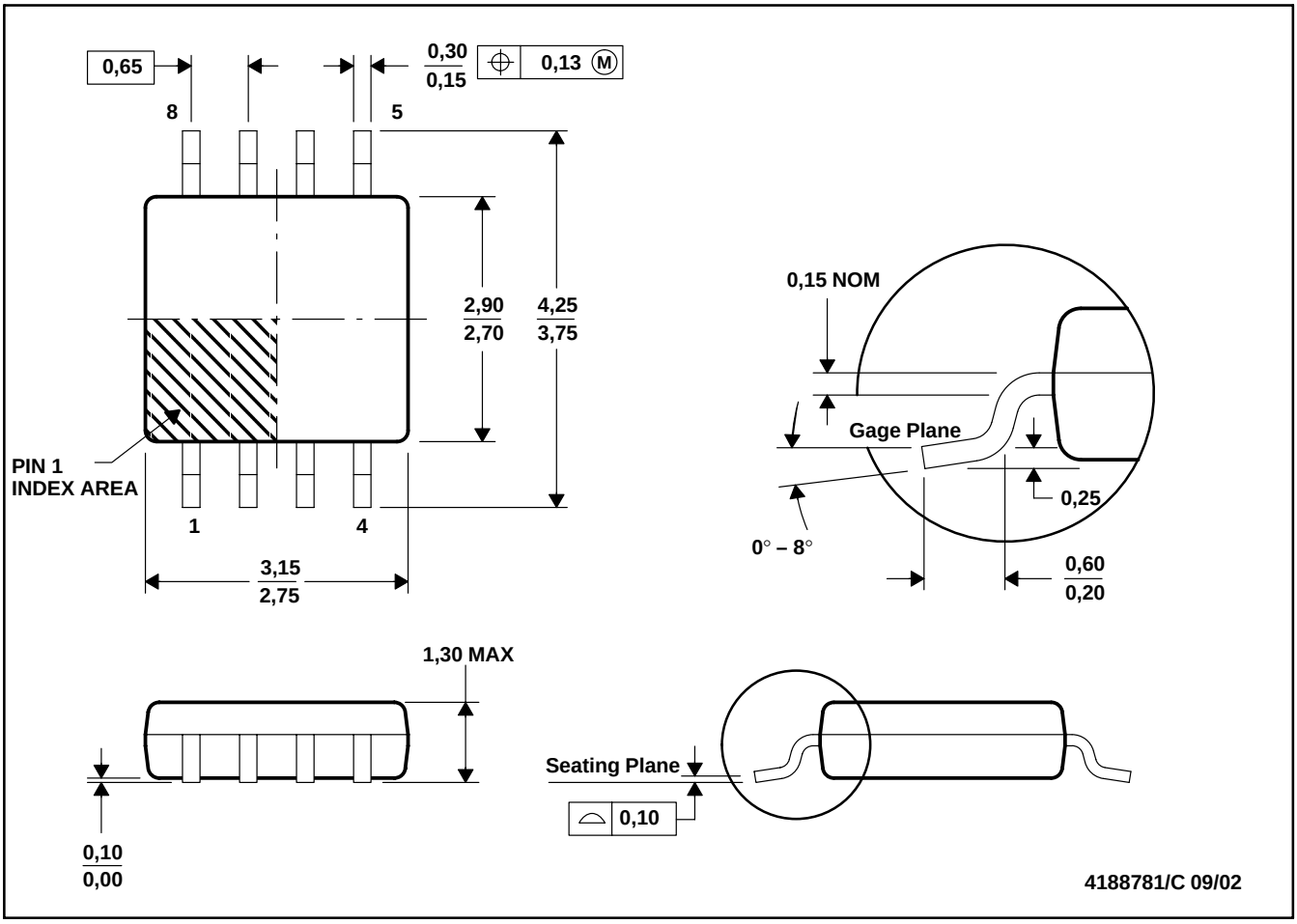
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) 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.
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.

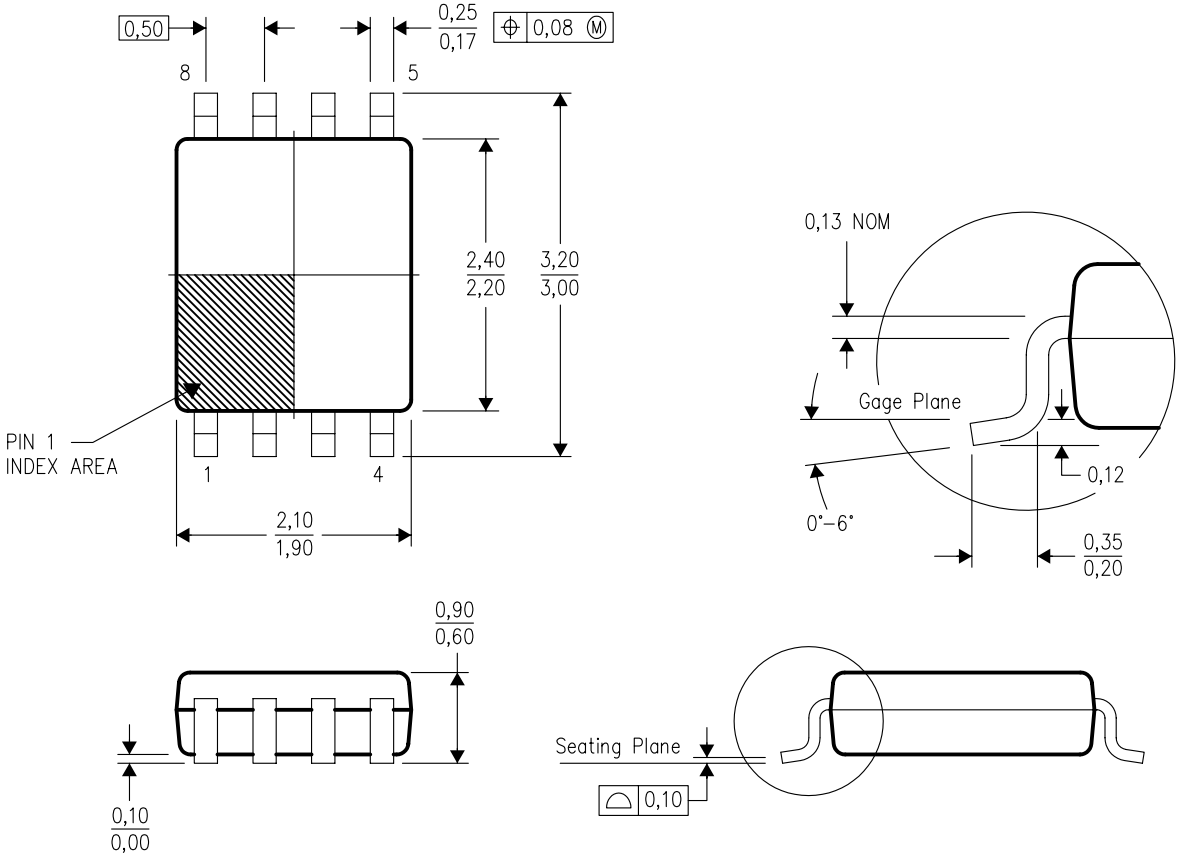
MPDS049B – MAY 1999 – REVISED OCTOBER 2002

DCT (R-PDSO-G8) **PLASTIC SMALL-OUTLINE PACKAGE**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion
D. Falls within JEDEC MO-187 variation DA.

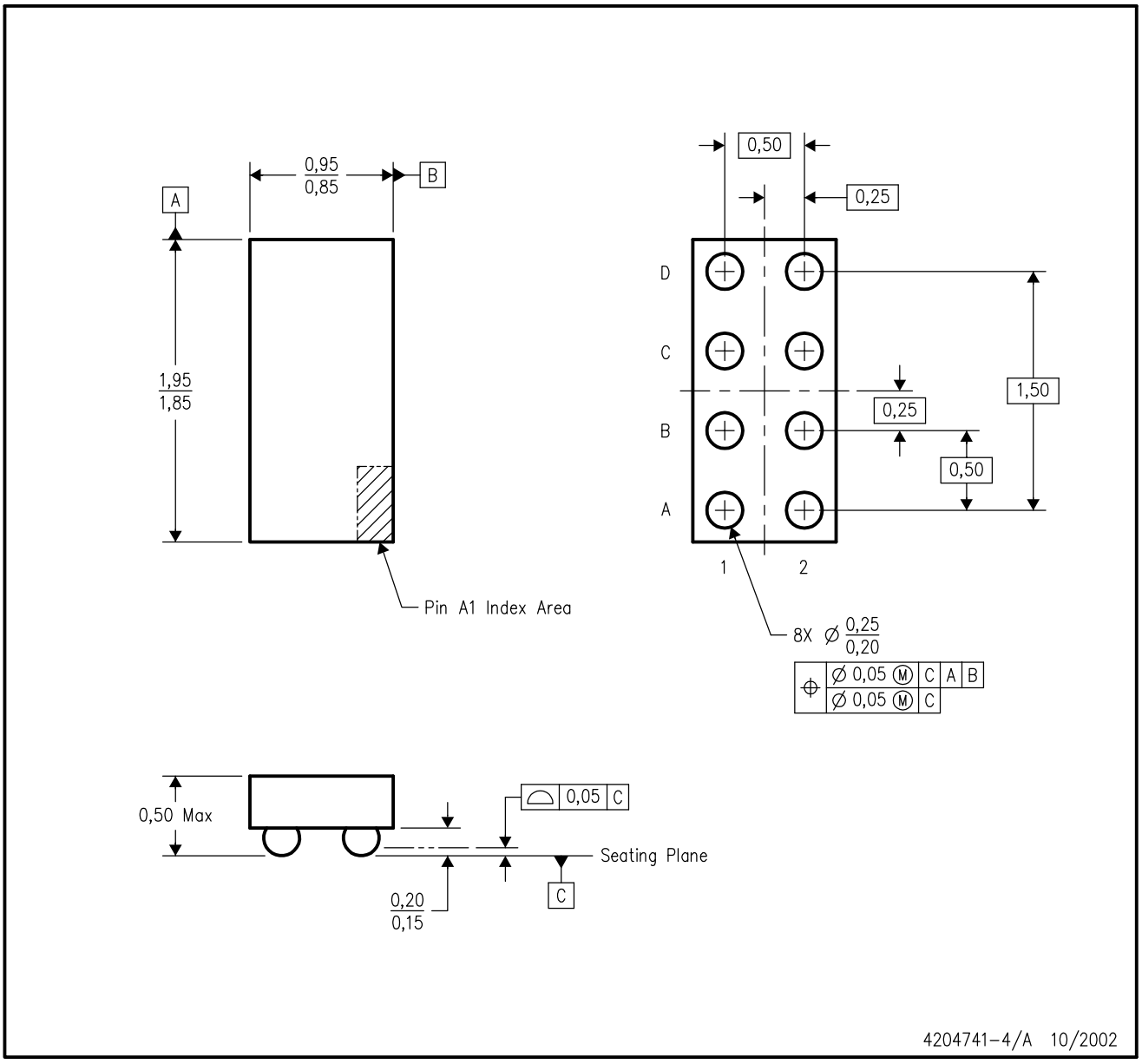
DCU (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE (DIE DOWN)



4200503/F 07/05

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–187 variation CA.

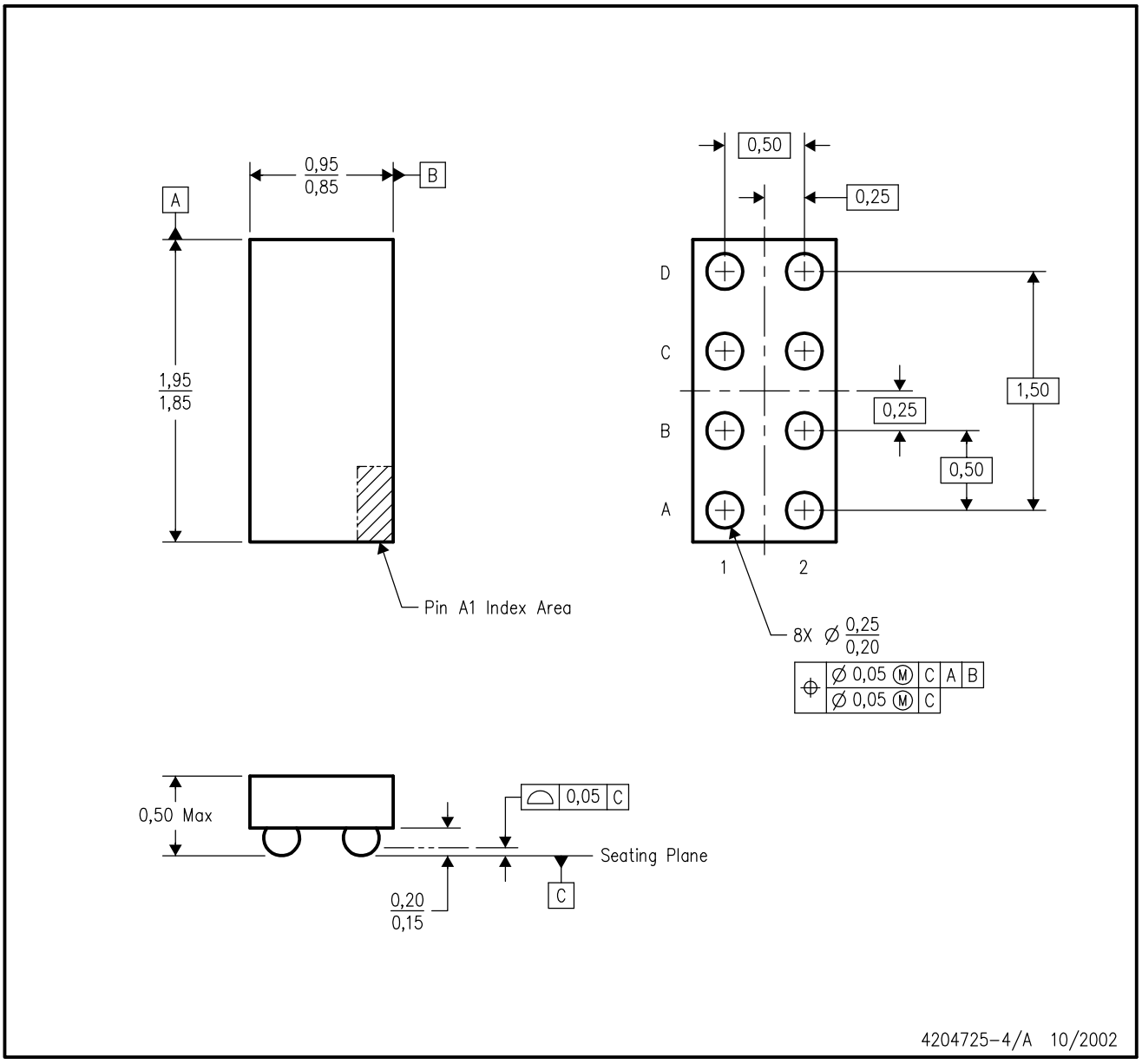
YZP (R–XBGA–N8) DIE–SIZE BALL GRID ARRAY



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. NanoFree™ package configuration.
D. This package is lead–free. Refer to the 8 YEP package (drawing 4204725) for tin–lead (SnPb).

NanoFree is a trademark of Texas Instruments.

YEP (R–XBGA–N8) DIE–SIZE BALL GRID ARRAY



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. NanoStar™ package configuration.
D. This package is tin–lead (SnPb). Refer to the 8 YZP package (drawing 4204741) for lead–free.

NanoStar is a trademark of Texas Instruments.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265