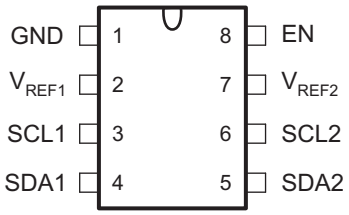
DUAL BIDIRECTIONAL I^2C BUS AND SMBus VOLTAGE-LEVEL TRANSLATOR

Check for Samples: PCA9306

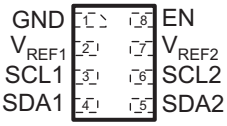
FEATURES

- **2-Bit Bidirectional Translator for SDA and SCL Lines in Mixed-Mode I^2C Applications**
- **I^2C and SMBus Compatible**
- **Less Than 1.5-ns Maximum Propagation Delay to Accommodate Standard-Mode and Fast-Mode I^2C Devices and Multiple Masters**
- **Allows Voltage-Level Translator Between**
  - **1.2-V V_{REF1} and 1.8-V, 2.5-V, 3.3-V, or 5-V V_{REF2}**
  - **1.8-V V_{REF1} and 2.5-V, 3.3-V, or 5-V V_{REF2}**
  - **2.5-V V_{REF1} and 3.3-V or 5-V V_{REF2}**
  - **3.3-V V_{REF1} and 5-V V_{REF2}**
- **Provides Bidirectional Voltage Translation With No Direction Pin**
- **Low 3.5-Ω ON-State Connection Between Input and Output Ports Provides Less Signal Distortion**
- **Open-Drain I^2C I/O Ports (SCL1, SDA1, SCL2, and SDA2)**
- **5-V Tolerant I^2C I/O Ports to Support Mixed-Mode Signal Operation**
- **High-Impedance SCL1, SDA1, SCL2, and SDA2 Pins for EN = Low**
- **Lock-Up-Free Operation for Isolation When EN = Low**
- **Flow-Through Pinout for Ease of Printed Circuit Board Trace Routing**
- **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)**

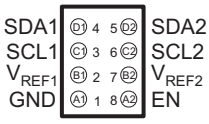
DCT OR DCU PACKAGE
(TOP VIEW)



DQE PACKAGE
(TOP VIEW)



YZT PACKAGE
(BOTTOM VIEW)



DESCRIPTION/ORDERING INFORMATION

This dual bidirectional I^2C and SMBus voltage-level translator, with an enable (EN) input, is operational from 1.2-V to 3.3-V V_{REF1} and 1.8-V to 5.5-V V_{REF2}.

The PCA9306 allows bidirectional voltage translations between 1.2 V and 5 V, without the use of a direction pin. The low ON-state resistance (r_{on}) of the switch allows connections to be made with minimal propagation delay. When EN is high, the translator switch is ON, and the SCL1 and SDA1 I/O are connected to the SCL2 and SDA2 I/O, respectively, allowing bidirectional data flow between ports. When EN is low, the translator switch is off, and a high-impedance state exists between ports.

In I^2C applications, the bus capacitance limit of 400 pF restricts the number of devices and bus length. Using the PCA9306 enables the system designer to isolate two halves of a bus; thus, more I^2C devices or longer trace length can be accommodated.

The PCA9306 also can be used to run two buses, one at 400-kHz operating frequency and the other at 100-kHz operating frequency. If the two buses are operating at different frequencies, the 100-kHz bus must be isolated when the 400-kHz operation of the other bus is required. If the master is running at 400 kHz, the maximum system operating frequency may be less than 400 kHz because of the delays added by the repeater.

As with the standard I^2C system, pullup resistors are required to provide the logic high levels on the translator's bus. The PCA9306 has a standard open-collector configuration of the I^2C bus. The size of these pullup resistors depends on the system, but each side of the repeater must have a pullup resistor. The device is designed to work with standard-mode and fast-mode I^2C devices, in addition to SMBus devices. Standard-mode I^2C devices only specify 3 mA in a generic I^2C system where standard-mode devices and multiple masters are possible. Under certain conditions, high termination currents can be used.

When the SDA1 or SDA2 port is low, the clamp is in the ON state, and a low resistance connection exists between the SDA1 and SDA2 ports. Assuming the higher voltage is on the SDA2 port when the SDA2 port is high, the voltage on the SDA1 port is limited to the voltage set by V_{REF1}. When the SDA1 port is high, the SDA2 port is pulled to the drain pullup supply voltage (V_{DPU}) by the pullup resistors. This functionality allows a seamless translation between higher and lower voltages selected by the user, without the need for directional control. The SCL1/SCL2 channel also functions as the SDA1/SDA2 channel.

All channels have the same electrical characteristics, and there is minimal deviation from one output to another in voltage or propagation delay. This is a benefit over discrete transistor voltage translation solutions, since the fabrication of the switch is symmetrical. The translator provides excellent ESD protection to lower-voltage devices and at the same time protects less ESD-resistant devices.t

ORDERING INFORMATION(1)

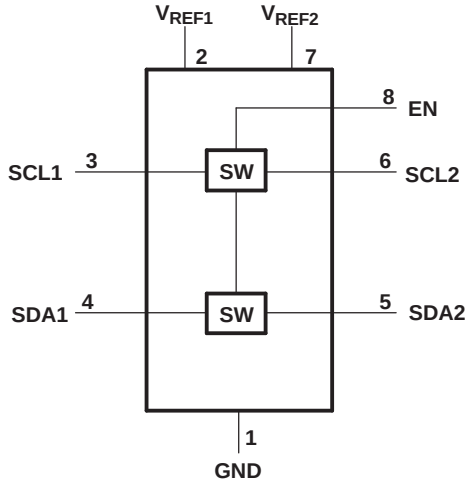
T_A	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING(3)
–40°C to 85°C	SSOP – DCT	Reel of 3000	PCA9306DCTR	7BD_ _ _
		Reel of 250	PCA9306DCTT	
	uQFN – DQE	Reel of 5000	PCA9306DQER	7F
	uCSP – YZT	Reel of 3000	PCA9306YZTR	_ _ _7FS
	VSSOP – DCU	Reel of 3000	PCA9306DCUR	7BD_
		Reel of 250	PCA9306DCUT	

(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.
(3) DCT/DQE/YZT/DCU: The actual top-side marking has three additional characters that designate the year, month, and wafer fab/assembly site.

TERMINAL FUNCTIONS

TERMINAL			DESCRIPTION
NAME	NO.		
	DCT, DCU, DQE	YZT	
GND	1	A1	Ground, 0 V
V_{REF1}	2	B1	Low-voltage-side reference supply voltage for SCL1 and SDA1
SCL1	3	C1	Serial clock, low-voltage side
SDA1	4	D1	Serial data, low-voltage side
SDA2	5	D2	Serial data, high-voltage side
SCL2	6	C2	Serial clock, high-voltage side
V_{REF2}	7	B2	High-voltage-side reference supply voltage for SCL2 and SDA2
EN	8	A2	Switch enable input

LOGIC DIAGRAM (POSITIVE LOGIC)



FUNCTION TABLE

INPUT EN(1)	TRANSLATOR FUNCTION
H	SCL1 = SCL2, SDA1 = SDA2
L	Disconnect

(1) The SCL switch conducts if EN is ≥ 1 V higher than SCL1 or SCL2. The same is true of SDA.

ABSOLUTE MAXIMUM RATINGS(1)

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

			MIN	MAX	UNIT
V_{REF1}	DC reference voltage range		–0.5	7	V
V_{REF2}	DC reference bias voltage range		–0.5	7	V
V_I	Input voltage range(2)		–0.5	7	V
$V_{I/O}$	Input/output voltage range(2)		–0.5	7	V
	Continuous channel current			128	mA
I_{IK}	Input clamp current	V_I < 0		–50	mA
θ_{JA}	Package thermal impedance(3)	DCT package		220	°C/W
		DCU package		227	
		DQE package		260	
		YZT package		102	
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) The input and input/output negative voltage ratings may be exceeded if the input and output current ratings are observed.
(3) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

			MIN	MAX	UNIT
$V_{I/O}$	Input/output voltage	SCL1, SDA1, SCL2, SDA2	0	5	V
V_{REF1}	Reference voltage		0	5	V
V_{REF2}	Reference voltage		0	5	V
EN	Enable input voltage		0	5	V
I_{PASS}	Pass switch current			64	mA
T_A	Operating free-air temperature		–40	85	°C

ELECTRICAL CHARACTERISTICS

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

PARAMETER			TEST CONDITIONS			MIN	TYP(1)	MAX	UNIT
V_{IK}	Input clamp voltage		I_I = –18 mA,	EN = 0 V				–1.2	V
I_{IH}	Input leakage current		V_I = 5 V,	EN = 0 V				5	μA
C_i(EN)	Input capacitance		V_I = 3 V or 0				11		pF
$C_{io(off)}$	Off capacitance	SCLn, SDAn	V_O = 3 V or 0,	EN = 0 V			4	6	pF
$C_{io(on)}$	On capacitance	SCLn, SDAn	V_O = 3 V or 0,	EN = 3 V			10.5	12.5	pF
r_{on} (2)	On-state resistance	SCLn, SDAn	V_I = 0,	I_O = 64 mA	EN = 4.5 V		3.5	5.5	Ω
					EN = 3 V		4.7	7	
					EN = 2.3 V		6.3	9.5	
					EN = 1.5 V		25.5	32	
			V_I = 2.4 V,	I_O = 15 mA	EN = 4.5 V	1	6	15	
					EN = 3 V	20	60	140	
			V_I = 1.7 V,	I_O = 15 mA	EN = 2.3 V	20	60	140	

(1) All typical values are at T_A = 25°C.
(2) Measured by the voltage drop between the SCL1 and SCL2, or SDA1 and SDA2 terminals, at the indicated current through the switch. ON-state resistance is determined by the lowest voltage of the two terminals.

AC PERFORMANCE (TRANSLATING DOWN) (3)

Switching Characteristics

over recommended operating free-air temperature range, EN = 3.3 V, V_{IH} = 3.3 V, V_{IL} = 0, V_M = 1.15 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L = 50 pF		C_L = 30 pF		C_L = 15 pF		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	SCL2 or SDA2	SCL1 or SDA1	0	0.8	0	0.6	0	0.3	ns
t_{PHL}			0	1.2	0	1	0	0.5	

(3) Translating down–the high voltage side driving toward the lower voltage side

Switching Characteristics

over recommended operating free-air temperature range, EN = 2.5 V, V_{IH} = 3.3 V, V_{IL} = 0, V_M = 0.75 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L = 50 pF		C_L = 30 pF		C_L = 15 pF		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	SCL2 or SDA2	SCL1 or SDA1	0	1	0	0.7	0	0.4	ns
t_{PHL}			0	1.3	0	1	0	0.6	

AC PERFORMANCE (TRANSLATING UP) (1)

Switching Characteristics

over recommended operating free-air temperature range, EN = 3.3 V, V_{IH} = 2.3 V, V_{IL} = 0, V_T = 3.3 V, V_M = 1.15 V, R_L = 300 Ω (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L = 50 pF		C_L = 30 pF		C_L = 15 pF		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	SCL1 or SDA1	SCL2 or SDA2	0	0.9	0	0.6	0	0.4	ns
t_{PHL}			0	1.4	0	1.1	0	0.7	

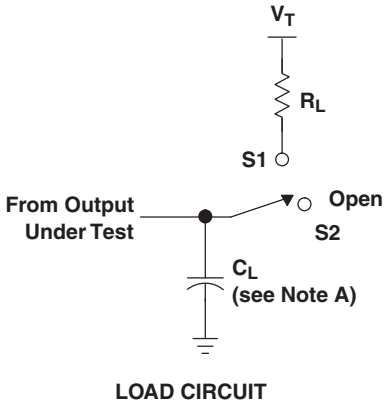
(1) Translating up–the lower voltage side driving toward the higher voltage side

Switching Characteristics

over recommended operating free-air temperature range, EN = 2.5 V, V_{IH} = 1.5 V, V_{IL} = 0, V_T = 2.5 V, V_M = 0.75 V, R_L = 300 Ω, (unless otherwise noted) (see Figure 1)

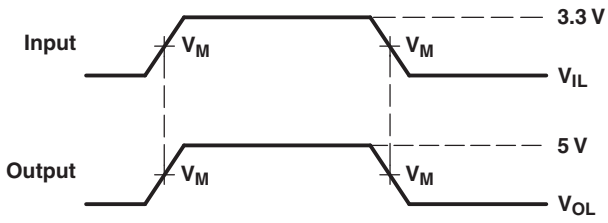
PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L = 50 pF		C_L = 30 pF		C_L = 15 pF		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	SCL1 or SDA1	SCL2 or SDA2	0	1	0	0.6	0	0.4	ns
t_{PHL}			0	1.3	0	1.3	0	0.8	

PARAMETER MEASUREMENT INFORMATION

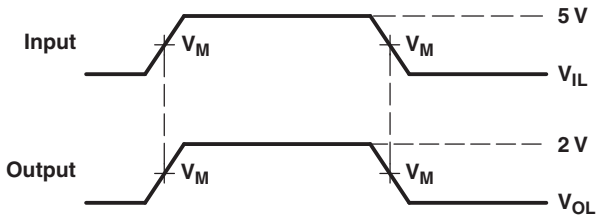


LOAD CIRCUIT

USAGE	SWITCH
Translating up	S1
Translating down	S2



TRANSLATING UP



TRANSLATING DOWN

NOTES: A. C_L includes probe and jig capacitance.
B. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2 ns, t_f ≤ 2 ns.
C. The outputs are measured one at a time, with one transition per measurement.

Figure 1. Load Circuit for Outputs

APPLICATION INFORMATION

General Applications of I^2C

In I^2C applications, the bus capacitance limit of 400 pF restricts the number of devices and bus length. Using the PCA9306 enables the system designer to isolate two halves of a bus; thus, more I^2C devices or longer trace length can be accommodated.

The PCA9306 also can be used to run two buses, one at 400-kHz operating frequency and the other at 100-kHz operating frequency. If the two buses are operating at different frequencies, the 100-kHz bus must be isolated when the 400-kHz operation of the other bus is required. If the master is running at 400 kHz, the maximum system operating frequency may be less than 400 kHz because of the delays added by the repeater.

As with the standard I^2C system, pullup resistors are required to provide the logic high levels on the translator's bus. The PCA9306 has a standard open-collector configuration of the I^2C bus. The size of these pullup resistors depends on the system, but each side of the repeater must have a pullup resistor. The device is designed to work with standard-mode and fast-mode I^2C devices, in addition to SMBus devices. Standard-mode I^2C devices only specify 3 mA in a generic I^2C system where standard-mode devices and multiple masters are possible. Under certain conditions, high termination currents can be used.

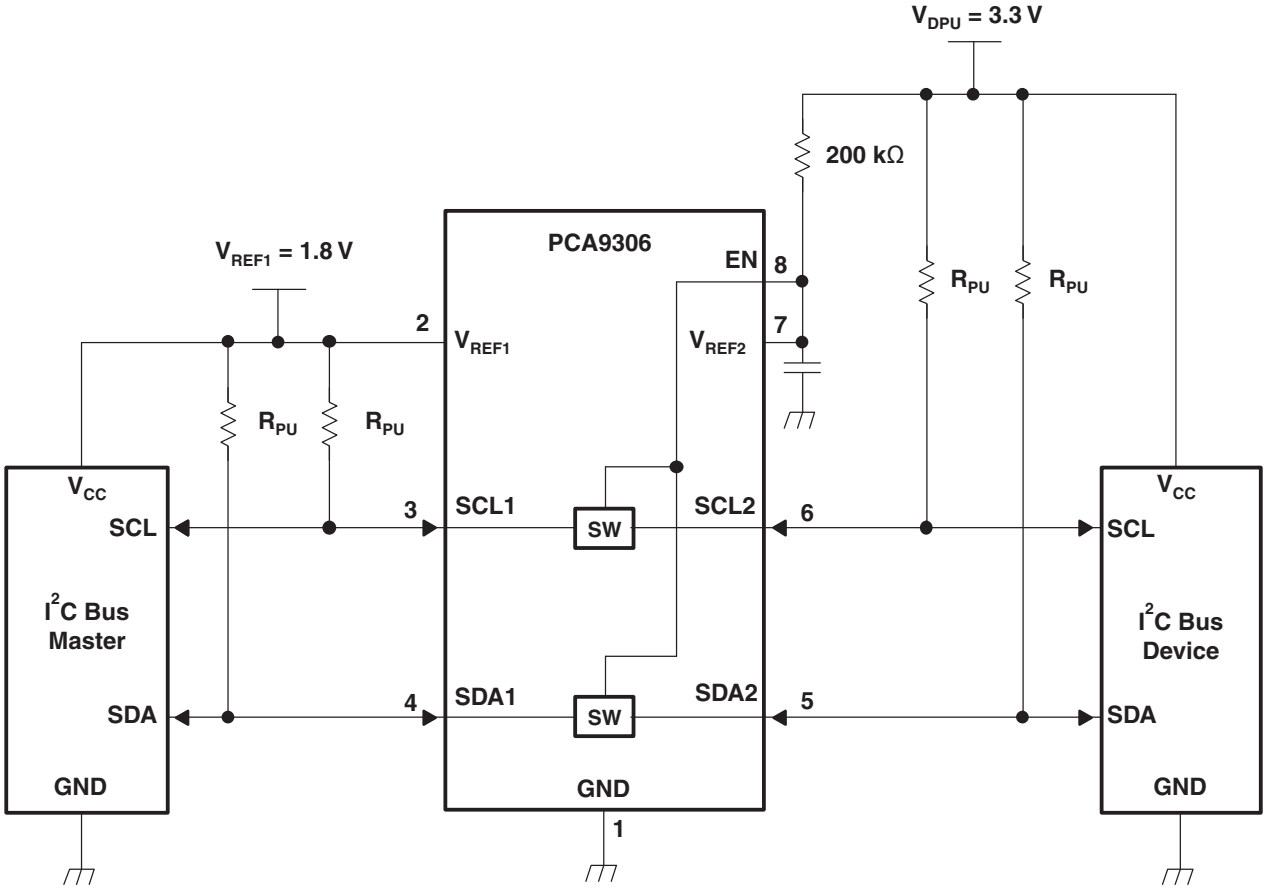


Figure 2. Typical Application Circuit (Switch Always Enabled)

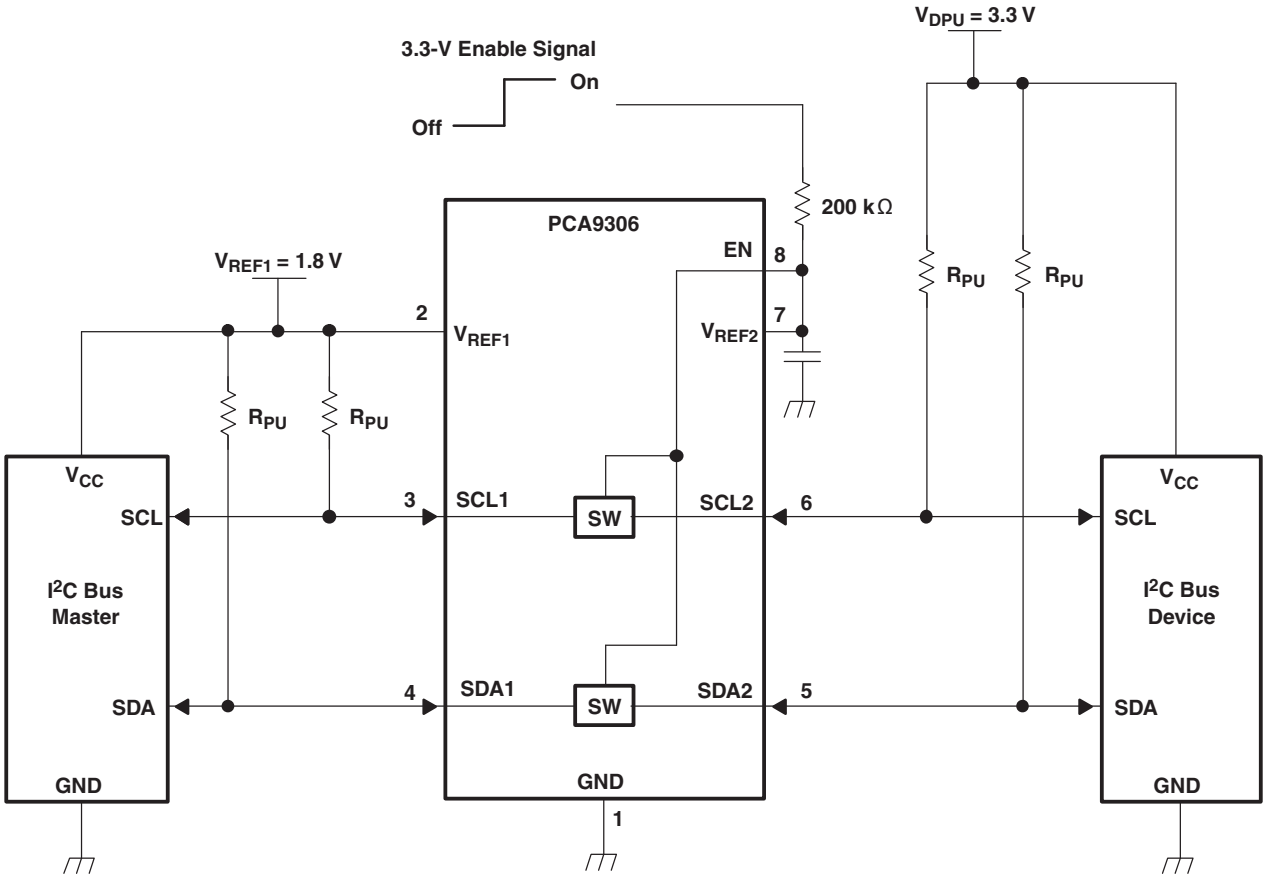


Figure 3. Typical Application Circuit (Switch Enable Control)

Bidirectional Translation

For the bidirectional clamping configuration (higher voltage to lower voltage or lower voltage to higher voltage), the EN input must be connected to V_{REF2} and both pins pulled to high-side V_{DPU} through a pullup resistor (typically 200 kΩ). This allows V_{REF2} to regulate the EN input. A filter capacitor on V_{REF2} is recommended. The I^2C bus master output can be totem pole or open drain (pullup resistors may be required) and the I^2C bus device output can be totem pole or open drain (pullup resistors are required to pull the SCL2 and SDA2 outputs to V_{DPU}). However, if either output is totem pole, data must be unidirectional or the outputs must be 3-stateable and be controlled by some direction-control mechanism to prevent high-to-low contentions in either direction. If both outputs are open drain, no direction control is needed.

The reference supply voltage (V_{REF1}) is connected to the processor core power-supply voltage.

Application Operating Conditions

see Figure 2

		MIN	TYP(1)	MAX	UNIT
V_{REF2}	Reference voltage	V_{REF1} + 0.6	2.1	5	V
EN	Enable input voltage	V_{REF1} + 0.6	2.1	5	V
V_{REF1}	Reference voltage	0	1.5	4.4	V
I_{PASS}	Pass switch current		14		mA
I_{REF}	Reference-transistor current		5		µA
T_A	Operating free-air temperature	–40		85	°C

(1) All typical values are at T_A = 25°C.

Sizing Pullup Resistor

The pullup resistor value needs to limit the current through the pass transistor, when it is in the on state, to about 15 mA. This ensures a pass voltage of 260 mV to 350 mV. If the current through the pass transistor is higher than 15 mA, the pass voltage also is higher in the on state. To set the current through each pass transistor at 15 mA, the pullup resistor value is calculated as:

$$R_{PU} = \frac{V_{DPU} - 0.35\ V}{0.015\ A}$$

The following table summarizes resistor values, reference voltages, and currents at 15 mA, 10 mA, and 3 mA. The resistor value shown in the +10% column (or a larger value) should be used to ensure that the pass voltage of the transistor is 350 mV or less. The external driver must be able to sink the total current from the resistors on both sides of the PCA9306 device at 0.175 V, although the 15 mA applies only to current flowing through the PCA9306 device.

PULLUP RESISTOR VALUES (1) (2)

PULLUP RESISTOR VALUE (Ω)						
V_{DPU}	15 mA		10 mA		3 mA	
	NOMINAL	+10% (3)	NOMINAL	+10% (3)	NOMINAL	+10% (3)
5 V	310	341	465	512	1550	1705
3.3 V	197	217	295	325	983	1082
2.5 V	143	158	215	237	717	788
1.8 V	97	106	145	160	483	532
1.5 V	77	85	115	127	383	422
1.2 V	57	63	85	94	283	312

(1) Calculated for V_{OL} = 0.35 V
(2) Assumes output driver V_{OL} = 0.175 V at stated current
(3) +10% to compensate for V_{DD} range and resistor tolerance

PCA9306 Bandwidth

The maximum frequency of the PCA9306 is dependent on the application. The device can operate at speeds of > 100MHz given the correct conditions. The maximum frequency is dependent upon the loading of the application. The PCA9306 behaves like a standard switch where the bandwidth of the device is dictated by the on resistance and on capacitance of the device.

Figure 4 shows a bandwidth measurement of the PCA9306 using a two-port network analyzer.

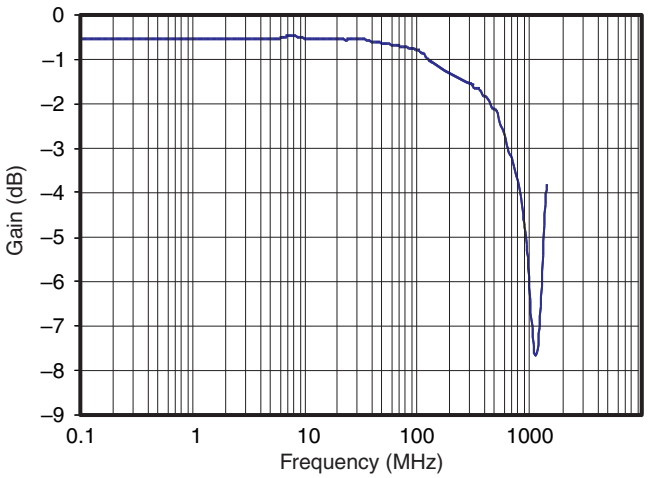


Figure 4. Bandwidth

The 3-dB point of the PCA9306 is ≈600 MHz. However, this measurement is an analog type of measurement. For digital applications the signal should not degrade up to the fifth harmonic of the digital signal. As a rule of thumb, the frequency bandwidth should be at least five times the maximum digital clock rate. This component of the signal is very important in determining the overall shape of the digital signal. In the case of the PCA9306, digital clock frequency of >100 MHz can be achieved.

The PCA9306 does not provide any drive capability like the PCA9515 or PCA9517 series of devices. Therefore higher frequency applications will require higher drive strength from the host side. No pullup resistor is needed on the host side (3.3 V) if the PCA9306 is being driven by standard CMOS totem pole output driver. Ideally, it is best to minimize the trace length from the PCA9306 on the sink side (1.8 V) to minimize signal degradation.

You can then use a simple formula to compute the maximum "practical" frequency component. Or the "knee" frequency (f_{knee}). All fast edges have an infinite spectrum of frequency components. However, there is an inflection (or "knee") in the frequency spectrum of fast edges where frequency components higher than f_{knee} are insignificant in determining the shape of the signal.

To calculate f_{knee}:

$f_{knee} = 0.5/RT$ *(10–80%)*

$f_{knee} = 0.4/RT$ *(20–80%)*

For signals with rise time characteristics based on 10- to 90-percent thresholds, f_{knee} is equal to 0.5 divided by the rise time of the signal. For signals with rise time characteristics based on 20- to 80-percent thresholds, which is very common in many of today's device specifications, f_{knee} is equal to 0.4 divided by the rise time of the signal.

Some guidelines to follow that will help maximize the performance of the device:

- Keep trace length to a minimum by placing the PCA9306 close to the I^2C output of the processor
- The trace length should be less than half the time of flight to reduce ringing and line reflections or non monotonic behavior in the switching region
- To reduce overshoots, a pullup resistor can be added on the 1.8 V side; be aware that a slower fall time is to be expected

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
PCA9306DCTR	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCTRE4	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCTRG4	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCTT	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCTTE4	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCTTG4	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCUR	ACTIVE	US8	DCU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCURE4	ACTIVE	US8	DCU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCURG4	ACTIVE	US8	DCU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCUT	ACTIVE	US8	DCU	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCUTE4	ACTIVE	US8	DCU	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DCUTG4	ACTIVE	US8	DCU	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCA9306DQER	ACTIVE	X2SON	DQE	8	5000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	
PCA9306YZTR	ACTIVE	DSBGA	YZT	8	3000	Green (RoHS & no Sb/Br)	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), 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.

OTHER QUALIFIED VERSIONS OF PCA9306 :

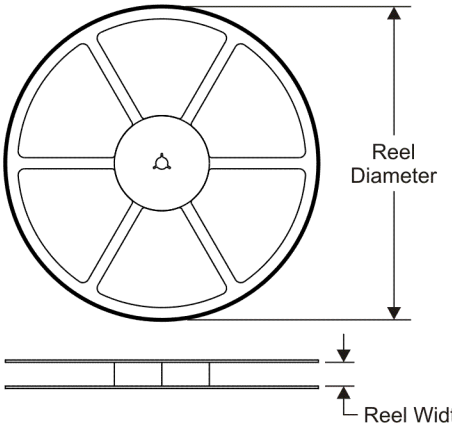
- Automotive: PCA9306-Q1

NOTE: Qualified Version Definitions:

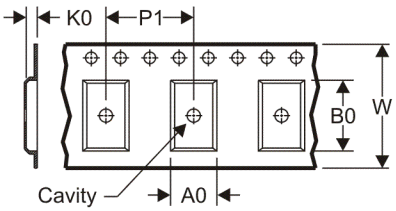
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

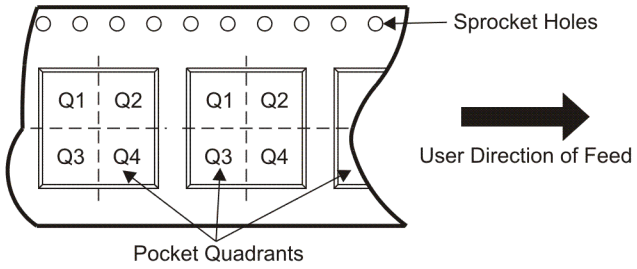


TAPE DIMENSIONS



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

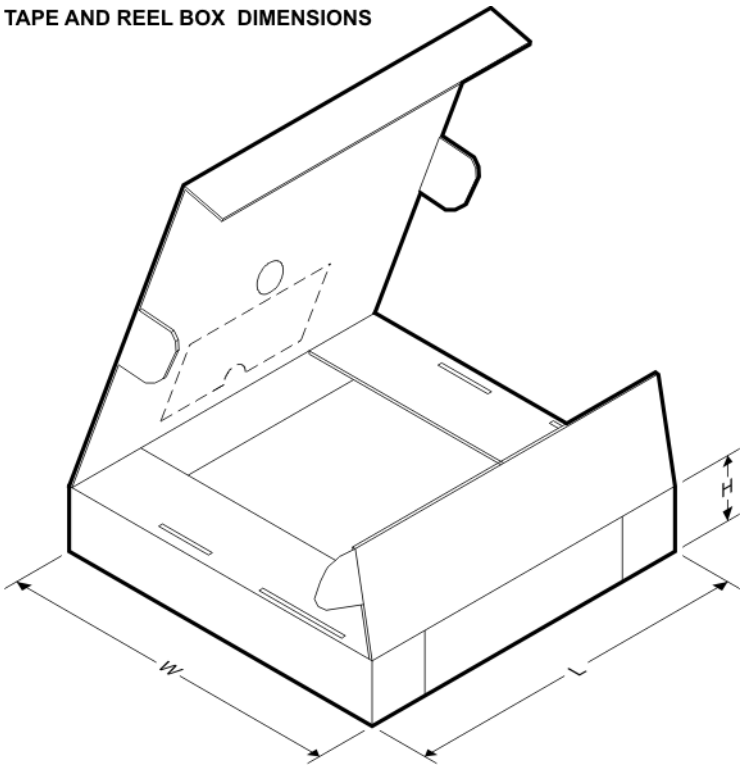
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
PCA9306DCUR	US8	DCU	8	3000	180.0	8.4	2.25	3.35	1.05	4.0	8.0	Q3
PCA9306DQER	X2SON	DQE	8	5000	180.0	8.4	1.17	1.67	0.73	4.0	8.0	Q1
PCA9306YZTR	DSBGA	YZT	8	3000	180.0	8.4	1.02	2.02	0.75	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS

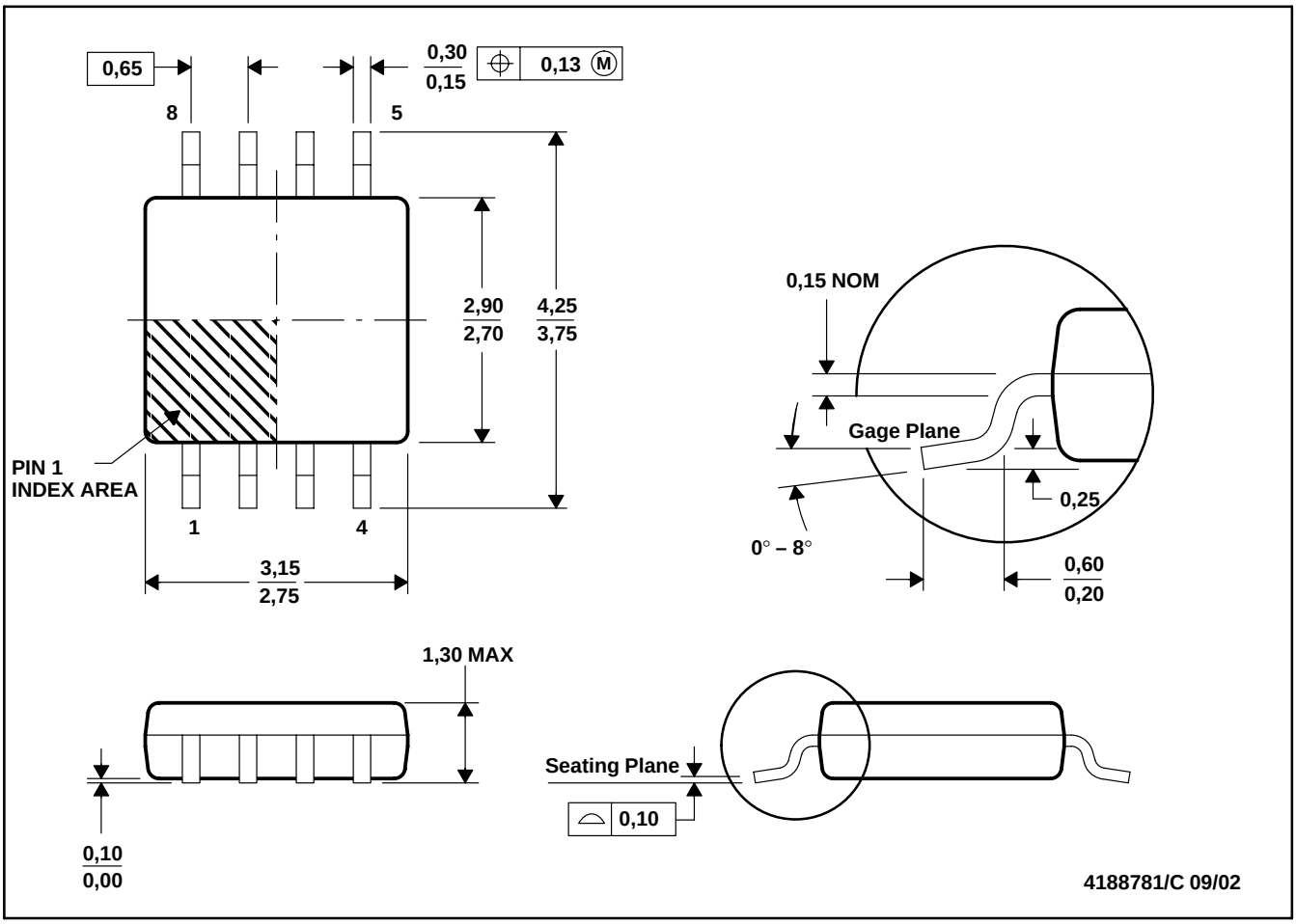


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
PCA9306DCUR	US8	DCU	8	3000	202.0	201.0	28.0
PCA9306DQER	X2SON	DQE	8	5000	202.0	201.0	28.0
PCA9306YZTR	DSBGA	YZT	8	3000	190.5	212.7	31.8

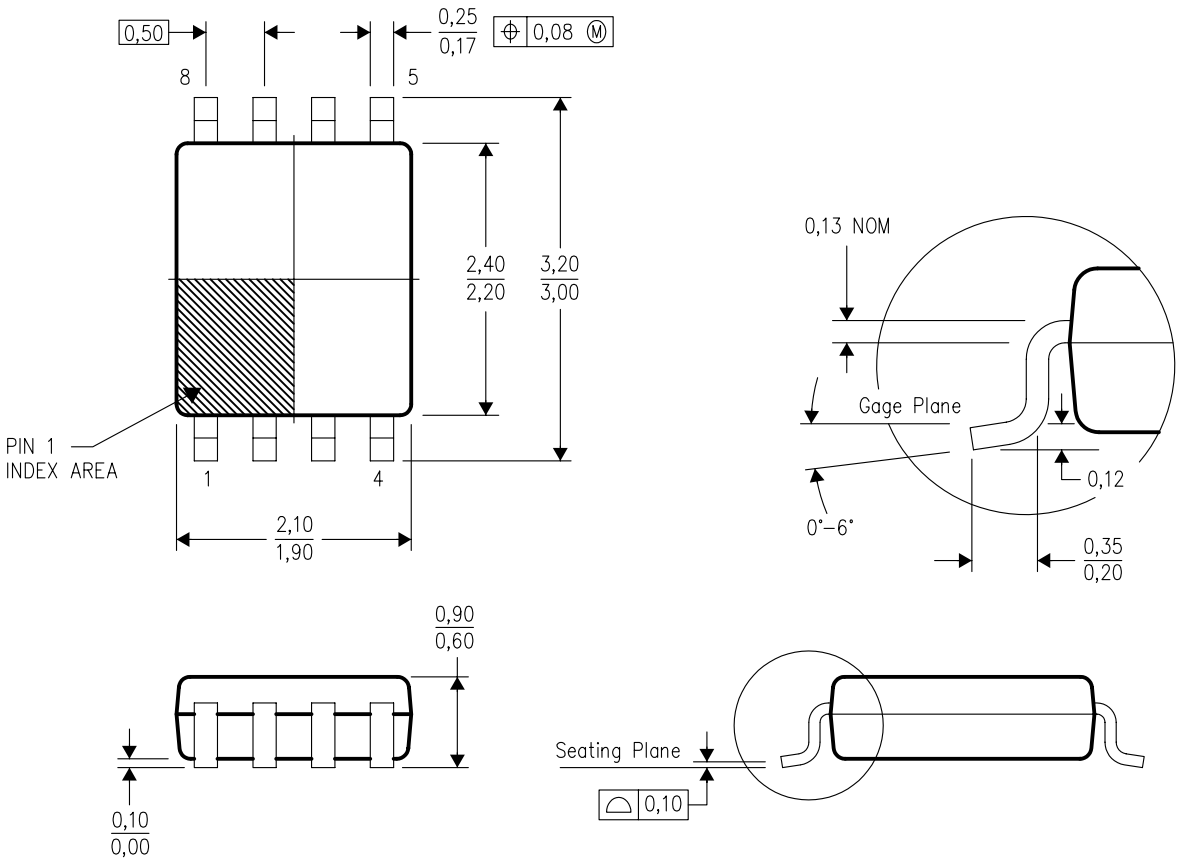
MPDS049B – MAY 1999 – REVISED OCTOBER 2002

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.

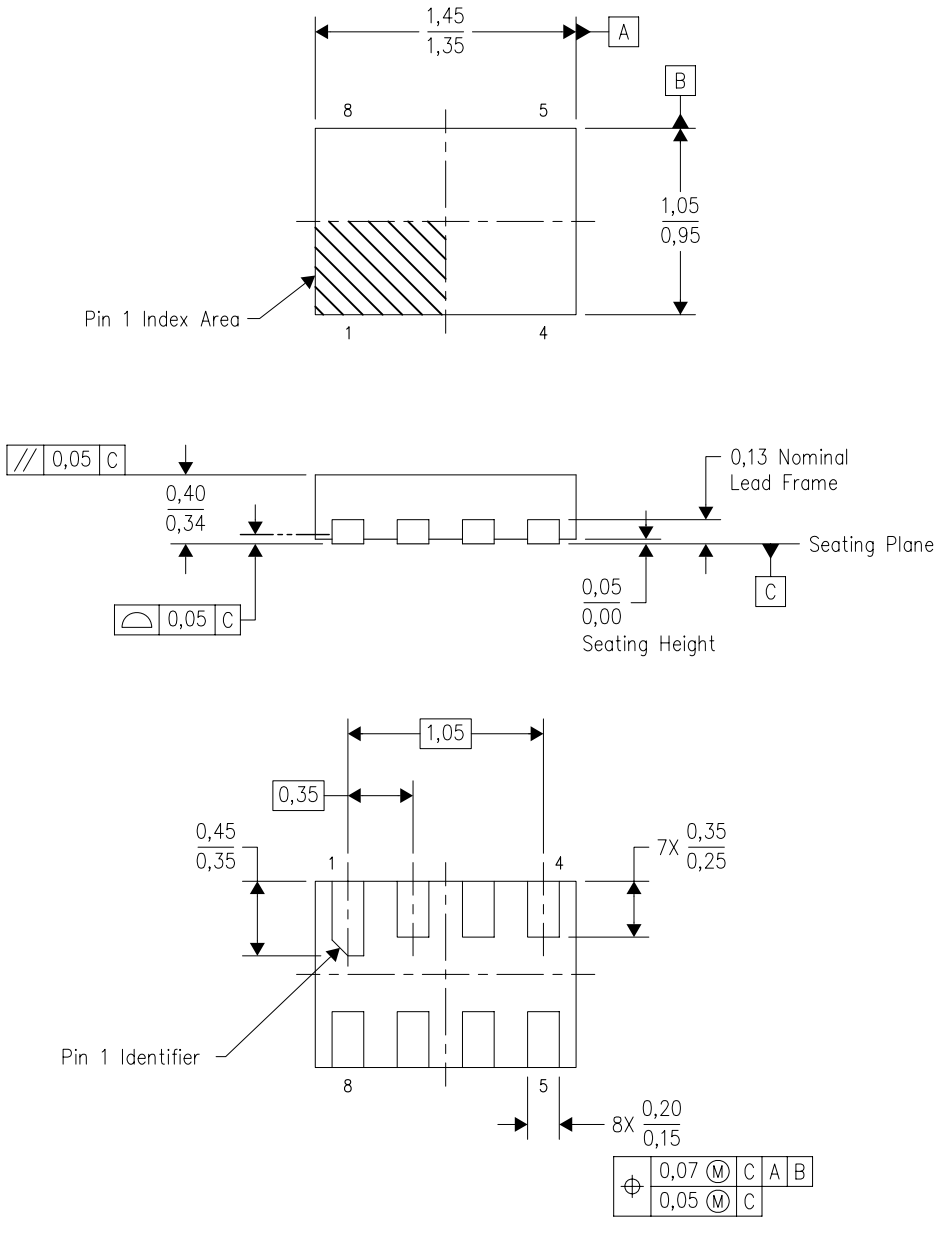
DCU (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE (DIE DOWN)



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.

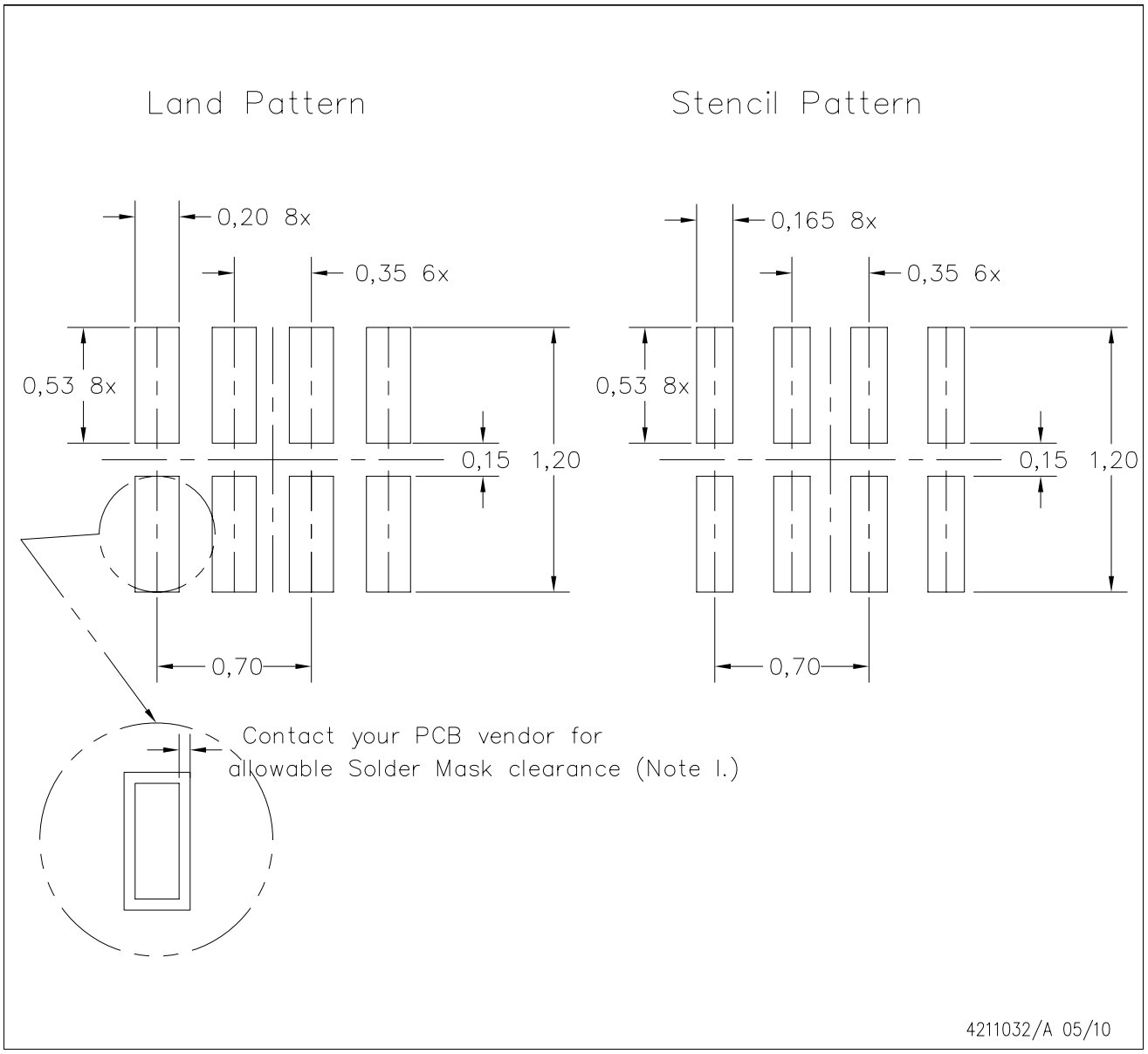
DQE (R–PX2SON–N8) PLASTIC SMALL OUTLINE NO–LEAD



4209779/B 10/2008

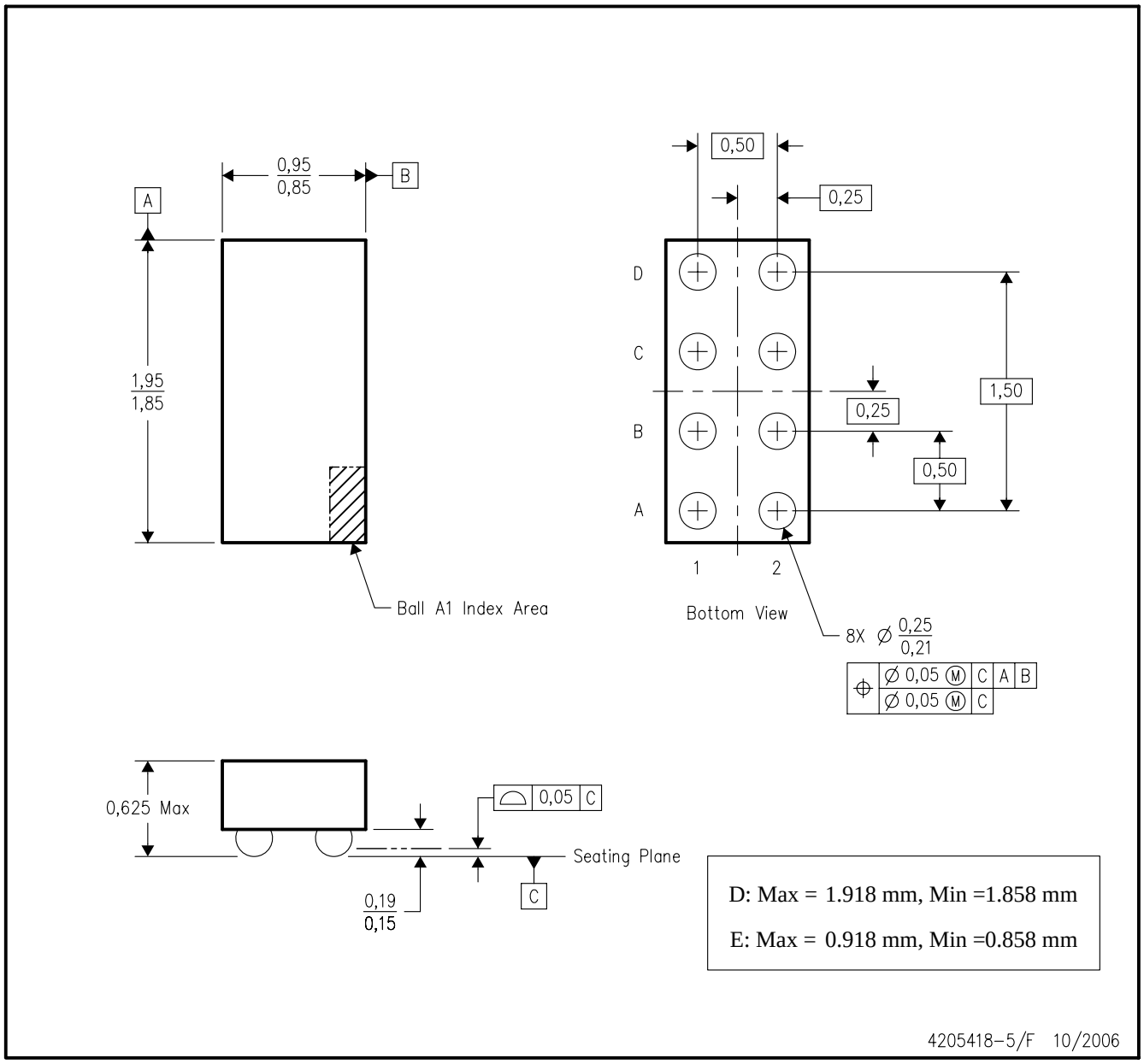
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. SON (Small Outline No–Lead) package configuration.
D. This package complies to JEDEC MO–287 variation X2EAF.

DQE (R–PX2SON–N8) PLASTIC SMALL OUTLINE NO–LEAD



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 designs.
D. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads. If 2 mil solder mask is outside PCB vendor capability, it is advised to omit solder mask.
E. Maximum stencil thickness 0,1016 mm (4 mils). All linear dimensions are in millimeters.
F. 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 stencil design considerations.
G. Over–printing land for acceptable area ratio is not viable due to land width and bridging potential. Customer may further reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.
H. Suggest stencils cut with lasers such as Fiber Laser that produce the greatest positional accuracy.
I. Component placement force should be minimized to prevent excessive paste block deformation.

YZT (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 YET package (drawing 4205421) for tin–lead (SnPb).

NanoFree 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 TI 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. Information of third parties may be subject to additional restrictions.

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.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

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

Products		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com	Wireless	www.ti.com/wireless-apps
RF/IF and ZigBee® Solutions	www.ti.com/lprf		
	TI E2E Community Home Page		e2e.ti.com

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