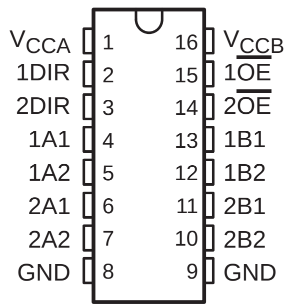
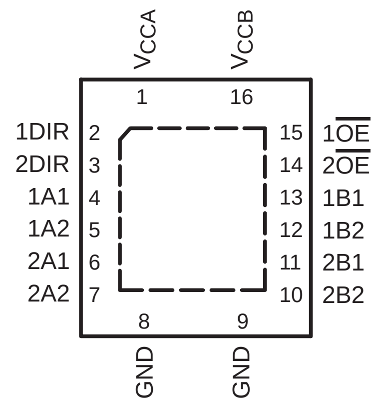
- **Control Inputs V_{IH}/V_{IL} Levels are Referenced to V_{CCA} Voltage**
- **Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.2-V to 3.6-V Power-Supply Range**
- **I/Os Are 4.6-V Tolerant**
- **I_{off} Supports Partial-Power-Down Mode Operation**

D, DB, DGV, OR PW PACKAGE
(TOP VIEW)



RGY PACKAGE
(TOP VIEW)



description/ordering information

This 4-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 1.2 V to 3.6 V. The B port is designed to track V_{CCB}. V_{CCB} accepts any supply voltage from 1.2 V to 3.6 V. This allows for universal low-voltage bidirectional translation between any of the 1.2-V, 1.5-V, 1.8-V, 2.5-V, and 3.3-V voltage nodes.

The SN74AVC4T245 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. The output-enable ($\overline{OE}$) input can be used to disable the outputs so the buses are effectively isolated.

The SN74AVC4T245 is designed so that the control pins (1DIR, 2DIR, 1$\overline{OE}$, and 2$\overline{OE}$) are 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.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 85°C	QFN − RGY	Tape and reel	SN74AVC4T245RGYR	
	SOIC − D	Tube	SN74AVC4T245D	
		Tape and reel	SN74AVC4T245DR	
	SSOP − DB	Tape and reel	SN74AVC4T245DBR	
	TSSOP − PW	Tube	SN74AVC4T245PW	
		Tape and reel	SN74AVC4T245PWR	
	TVSOP − DGV	Tape and reel	SN74AVC4T245DGVR	

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

description/ordering information (continued)

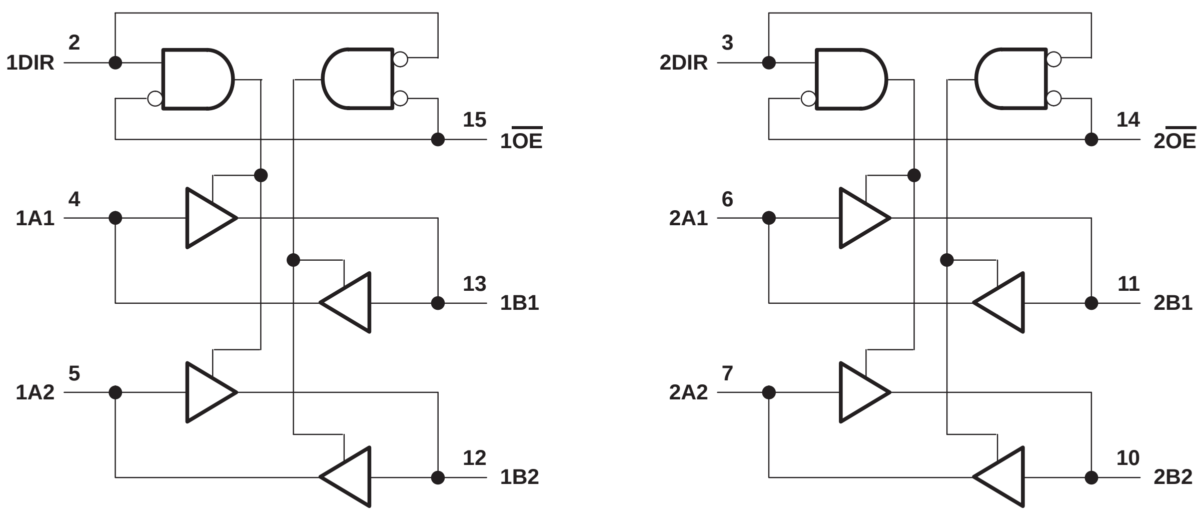
The V_{CC} isolation feature ensures that if either V_{CC} input is at GND, then both ports are in the high-impedance state.

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 4-bit section)

INPUTS		OPERATION
$\overline{OE}$	DIR	
L	L	B data to A bus
L	H	A data to B bus
H	X	Isolation

logic diagram (positive logic)



TEXAS INSTRUMENTS
POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

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

Supply voltage range, V_{CCA} and V_{CCB}	−0.5 V to 4.6 V
Input voltage range, V_I (see Note 1): I/O ports (A port)	−0.5 V to 4.6 V
I/O ports (B port)	−0.5 V to 4.6 V
Control inputs	−0.5 V to 4.6 V
Voltage range applied to any output in the high-impedance or power-off state, V_O (see Note 1): (A port)	−0.5 V to 4.6 V
(B port)	−0.5 V to 4.6 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} + 0.5 V
(B port)	−0.5 V to V_{CCB} + 0.5 V
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_{CCA}, V_{CCB}, or GND	±100 mA
Package thermal impedance, θ_{JA} (see Note 3): D package	73°C/W
(see Note 3): DB package	82°C/W
(see Note 3): DGV package	120°C/W
(see Note 3): PW package	108°C/W
(see Note 4): RGY package	39°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 voltage and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
2. The output positive-voltage rating may be exceeded up to 4.6 V maximum if the output current rating is observed.
3. The package thermal impedance is calculated in accordance with JESD 51-7.
4. The package thermal impedance is calculated in accordance with JESD 51-5.

PRODUCT PREVIEW

recommended operating conditions (see Notes 5 through 7)

			V_{CCI}	V_{CCO}	MIN	MAX	UNIT
V_{CCA}	Supply voltage				1.2	3.6	V
V_{CCB}	Supply voltage				1.2	3.6	V
V_{IH}	High-level input voltage	Data inputs (see Note 8)	1.2 V to 1.95 V		$V_{CCI} \times 0.65$		V
			1.95 V to 2.7 V		1.6		
			2.7 V to 3.6 V		2		
V_{IL}	Low-level input voltage	Data inputs (see Note 8)	1.2 V to 1.95 V			$V_{CCI} \times 0.35$	V
			1.95 V to 2.7 V			0.7	
			2.7 V to 3.6 V			0.8	
V_{IH}	High-level input voltage	DIR (Referenced to V_{CCA}) (see Note 9)	1.2 V to 1.95 V		$V_{CCA} \times 0.65$		V
			1.95 V to 2.7 V		1.6		
			2.7 V to 3.6 V		2		
V_{IL}	Low-level input voltage	DIR (Referenced to V_{CCA}) (see Note 9)	1.2 V to 1.95 V			$V_{CCA} \times 0.35$	V
			1.95 V to 2.7 V			0.7	
			2.7 V to 3.6 V			0.8	
V_I	Input voltage				0	3.6	V
V_O	Output voltage	Active state			0	V_{CCO}	V
		3-state			0	3.6	
I_{OH}	High-level output current			1.2 V		−3	mA
				1.4 V to 1.6 V		−6	
				1.65 V to 1.95 V		−8	
				2.3 V to 2.7 V		−9	
				3 V to 3.6 V		−12	
I_{OL}	Low-level output current			1.2 V		3	mA
				1.4 V to 1.6 V		6	
				1.65 V to 1.95 V		8	
				2.3 V to 2.7 V		9	
				3 V to 3.6 V		12	
$\Delta t/\Delta v$	Input transition rise or fall rate					5	ns/V
T_A	Operating free-air temperature				−40	85	°C

NOTES: 5. V_{CCI} is the V_{CC} associated with the data input port.
6. V_{CCO} is the V_{CC} associated with the output port.
7. 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.
8. For V_{CCI} values not specified in the data sheet, $V_{IH(min)} = V_{CCI}$ x 0.7 V, $V_{IL(max)} = V_{CCI}$ x 0.3 V.
9. For V_{CCI} values not specified in the data sheet, $V_{IH(min)} = V_{CCA}$ x 0.7 V, $V_{IL(max)} = V_{CCA}$ x 0.3 V.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Notes 10 and 11)

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	$V_I = V_{IH}$	1.2 V to 3.6 V	1.2 V to 3.6 V				V_{CCO}−0.2 V		V
		I_{OH} = −3 mA		1.2 V	1.2 V		0.95				
		I_{OH} = −6 mA		1.4 V	1.4 V				1.05		
		I_{OH} = −8 mA		1.65 V	1.65 V				1.2		
		I_{OH} = −9 mA		2.3 V	2.3 V				1.75		
		I_{OH} = −12 mA		3 V	3 V				2.3		
V_{OL}		I_{OL} = 100 μA	$V_I = V_{IL}$	1.2 V to 3.6 V	1.2 V to 3.6 V					0.2	V
		I_{OL} = 3 mA		1.2 V	1.2 V		0.25				
		I_{OL} = 6 mA		1.4 V	1.4 V					0.35	
		I_{OL} = 8 mA		1.65 V	1.65 V					0.45	
		I_{OL} = 9 mA		2.3 V	2.3 V					0.55	
		I_{OL} = 12 mA		3 V	3 V					0.7	
I_I	DIR input	$V_I = V_{CCA}$ or GND		1.2 V to 3.6 V	1.2 V to 3.6 V		±0.025	±0.25		±1	μA
I_{off}	A or B port	V_I or V_O = 0 to 3.6 V		0 V	0 to 3.6 V		±0.1	±1		±5	μA
				0 to 3.6 V	0 V		±0.1	±1		±5	
I_{OZ}†	A or B port	$V_O = V_{CCO}$ or GND, $V_I = V_{CCI}$ or GND	$\overline{OE} = V_{IH}$	3.6 V	3.6 V		±0.5	±2.5		±5	μA
I_{CCA}		$V_I = V_{CCI}$ or GND	I_O = 0	1.2 V to 3.6 V	1.2 V to 3.6 V						μA
				0 V	3.6 V						
				3.6 V	0 V						
I_{CCB}		$V_I = V_{CCI}$ or GND	I_O = 0	1.2 V to 3.6 V	1.2 V to 3.6 V						μA
				0 V	3.6 V						
				3.6 V	0 V						
$I_{CCA} + I_{CCB}$		$V_I = V_{CCI}$ or GND	I_O = 0	1.2 V to 3.6 V	1.2 V to 3.6 V						μA
C_i	Control inputs	V_I = 3.3 V or GND		3.3 V	3.3 V						pF
C_{io}	A or B ports	V_O = 3.3 V or GND		3.3 V	3.3 V						pF

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

PRODUCT PREVIEW

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 1.2 V (see Figure 11)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.2 V	V_{CCB} = 1.5 V	V_{CCB} = 1.8 V	V_{CCB} = 2.5 V	V_{CCB} = 3.3 V	UNIT
			TYP	TYP	TYP	TYP	TYP	
t_{PLH}	A	B						ns
t_{PHL}								
t_{PLH}	B	A						ns
t_{PHL}								
t_{PZH}	$\overline{OE}$	A						ns
t_{PZL}								
t_{PZH}	$\overline{OE}$	B						ns
t_{PZL}								
t_{PHZ}	$\overline{OE}$	A						ns
t_{PLZ}								
t_{PHZ}	$\overline{OE}$	B						ns
t_{PLZ}								

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 1.5 V ± 0.1 V (see Figure 11)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.2 V	V_{CCB} = 1.5 V ± 0.1 V		V_{CCB} = 1.8 V ± 0.15 V		V_{CCB} = 2.5 V ± 0.2 V		V_{CCB} = 3.3 V ± 0.3 V		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B										ns
t_{PHL}												
t_{PLH}	B	A										ns
t_{PHL}												
t_{PZH}	$\overline{OE}$	A										ns
t_{PZL}												
t_{PZH}	$\overline{OE}$	B										ns
t_{PZL}												
t_{PHZ}	$\overline{OE}$	A										ns
t_{PLZ}												
t_{PHZ}	$\overline{OE}$	B										ns
t_{PLZ}												

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 1.8 V ± 0.15 V (see Figure 11)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.2 V	V_{CCB} = 1.5 V ± 0.1 V		V_{CCB} = 1.8 V ± 0.15 V		V_{CCB} = 2.5 V ± 0.2 V		V_{CCB} = 3.3 V ± 0.3 V		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B										ns
t_{PHL}												
t_{PLH}	B	A										ns
t_{PHL}												
t_{PZH}	$\overline{OE}$	A										ns
t_{PZL}												
t_{PZH}	$\overline{OE}$	B										ns
t_{PZL}												
t_{PHZ}	$\overline{OE}$	A										ns
t_{PLZ}												
t_{PHZ}	$\overline{OE}$	B										ns
t_{PLZ}												

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 2.5 V ± 0.2 V (see Figure 11)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.2 V	V_{CCB} = 1.5 V ± 0.1 V		V_{CCB} = 1.8 V ± 0.15 V		V_{CCB} = 2.5 V ± 0.2 V		V_{CCB} = 3.3 V ± 0.3 V		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B										ns
t_{PHL}												
t_{PLH}	B	A										ns
t_{PHL}												
t_{PZH}	$\overline{OE}$	A										ns
t_{PZL}												
t_{PZH}	$\overline{OE}$	B										ns
t_{PZL}												
t_{PHZ}	$\overline{OE}$	A										ns
t_{PLZ}												
t_{PHZ}	$\overline{OE}$	B										ns
t_{PLZ}												

PRODUCT PREVIEW

PRODUCT PREVIEW

switching characteristics over recommended operating free-air temperature range, V_{CCA} = 3.3 V ± 0.3 V (see Figure 11)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CCB} = 1.2 V	V_{CCB} = 1.5 V ± 0.1 V		V_{CCB} = 1.8 V ± 0.15 V		V_{CCB} = 2.5 V ± 0.2 V		V_{CCB} = 3.3 V ± 0.3 V		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A	B										ns
t_{PHL}												
t_{PLH}	B	A										ns
t_{PHL}												
t_{PZH}	$\overline{OE}$	A										ns
t_{PZL}												
t_{PZH}	$\overline{OE}$	B										ns
t_{PZL}												
t_{PHZ}	$\overline{OE}$	A										ns
t_{PLZ}												
t_{PHZ}	$\overline{OE}$	B										ns
t_{PLZ}												

operating characteristics, T_A = 25°C

PARAMETER			TEST CONDITIONS	V_{CCA} = V_{CCB} = 1.2 V	V_{CCA} = V_{CCB} = 1.5 V	V_{CCA} = V_{CCB} = 1.8 V	V_{CCA} = V_{CCB} = 2.5 V	V_{CCA} = V_{CCB} = 3.3 V	UNIT
				TYP	TYP	TYP	TYP	TYP	
C_{pdA}†	A to B	Outputs Enabled	C_L = 0, f = 10 MHz, t_r = t_f =1 ns						pF
		Outputs Disabled							
	B to A	Outputs Enabled							
		Outputs Disabled							
C_{pdB}†	A to B	Outputs Enabled	C_L = 0, f = 10 MHz, t_r = t_f =1 ns						pF
		Outputs Disabled							
	B to A	Outputs Enabled							
		Outputs Disabled							

† 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. To guard against such power-up problems, take the following precautions:

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})

V_{CCB}	V_{CCA}						UNIT
	0 V	1.2 V	1.5 V	1.8 V	2.5 V	3.3 V	
0 V							μA
1.2 V							
1.5 V							
1.8 V							
2.5 V							
3.3 V							

TABLE 1

PRODUCT PREVIEW

PRODUCT PREVIEW

TYPICAL CHARACTERISTICS

TYPICAL PROPAGATION DELAY (A to B) vs LOAD CAPACITANCE, T_A = 25°C, V_{CCA} = 1.2 V

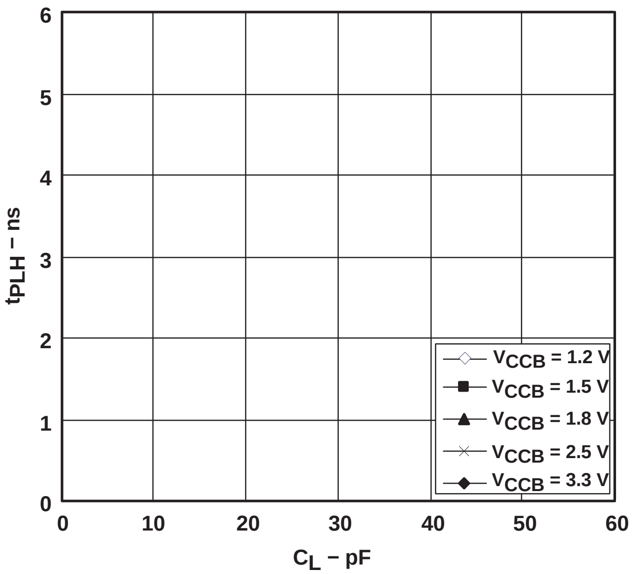


Figure 1

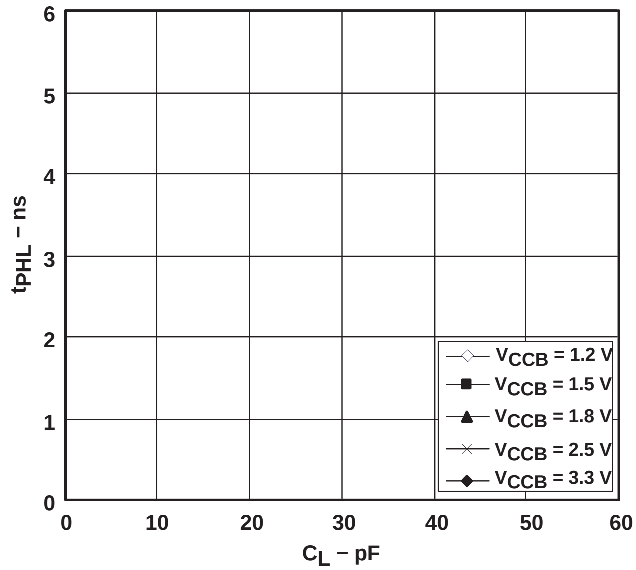


Figure 2

TYPICAL PROPAGATION DELAY (A to B) vs LOAD CAPACITANCE, T_A = 25°C, V_{CCA} = 1.5 V

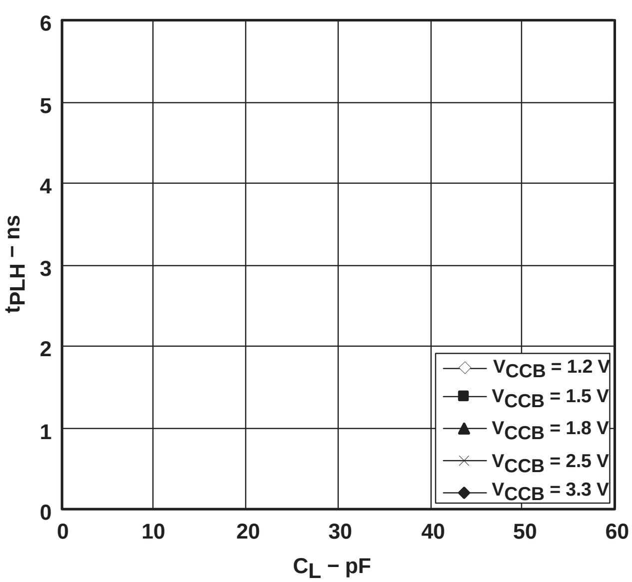


Figure 3

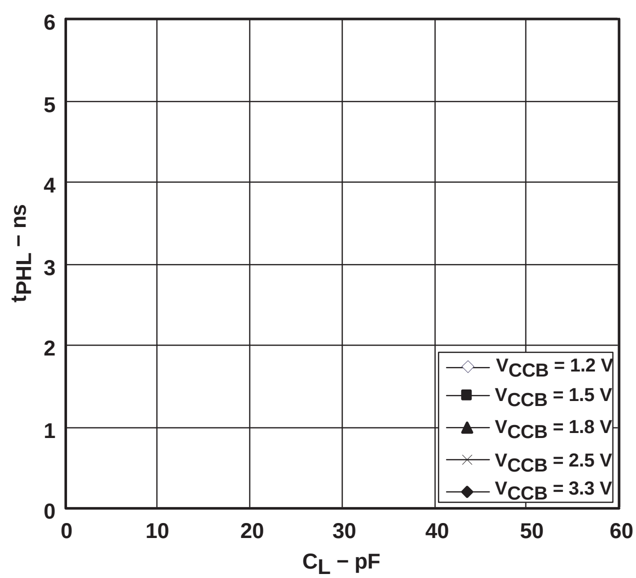


Figure 4

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

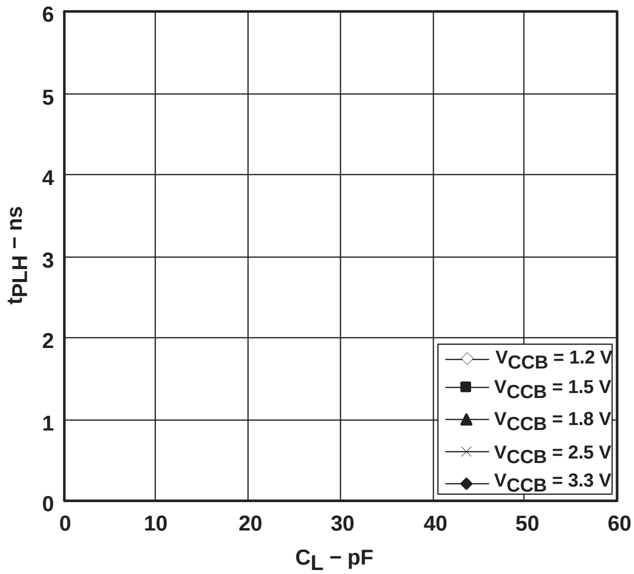


Figure 5

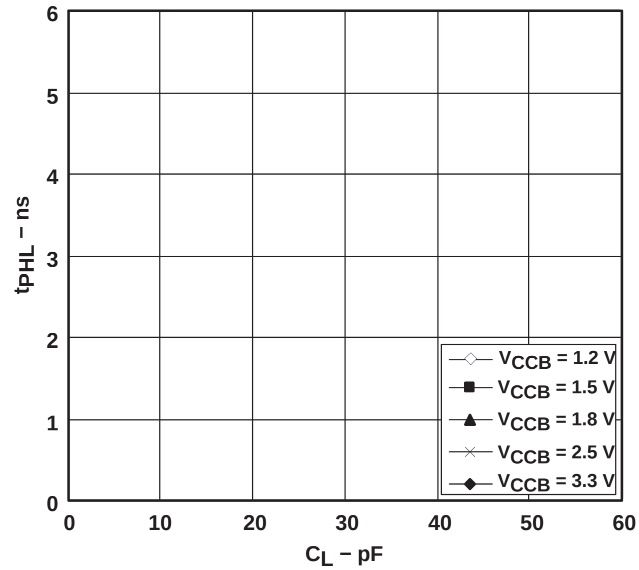


Figure 6

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

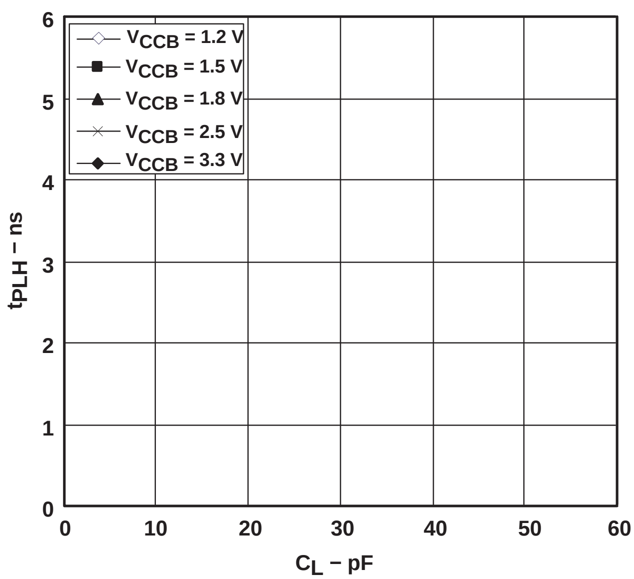


Figure 7

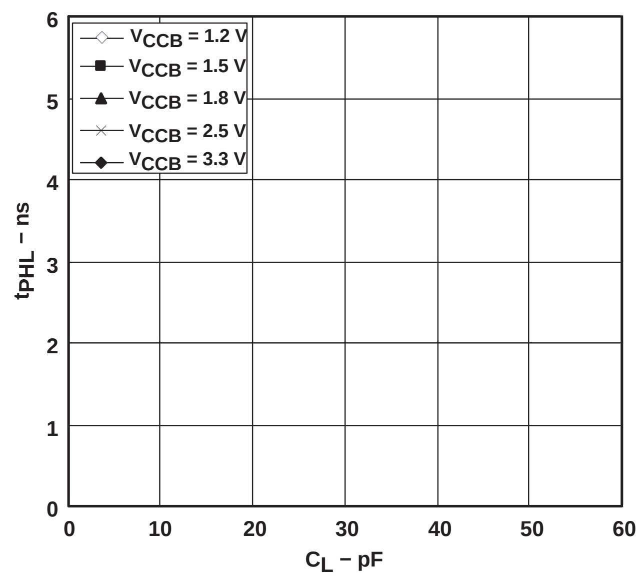


Figure 8

PRODUCT PREVIEW

PRODUCT PREVIEW

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

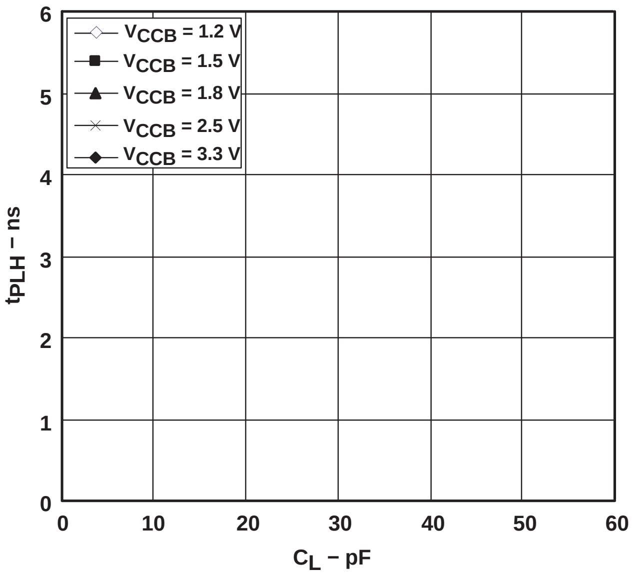


Figure 9

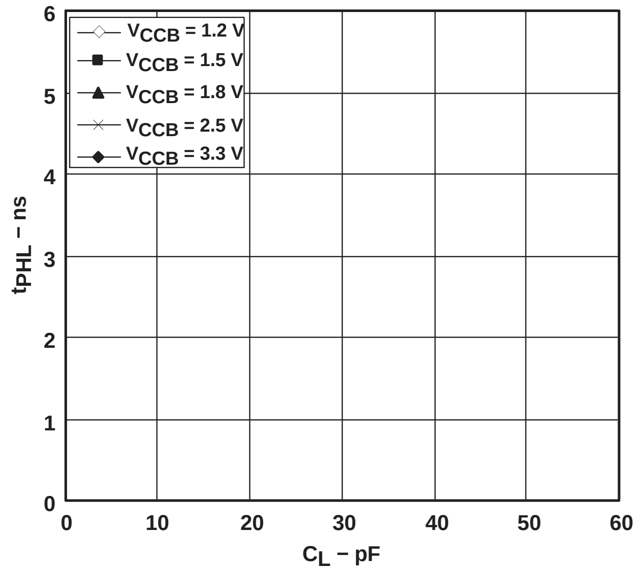
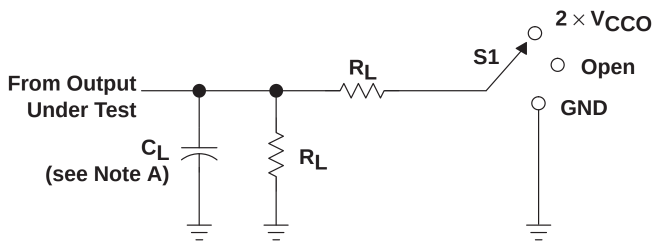


Figure 10

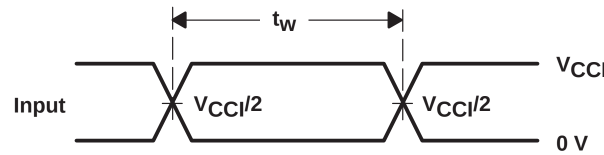
PARAMETER MEASUREMENT INFORMATION



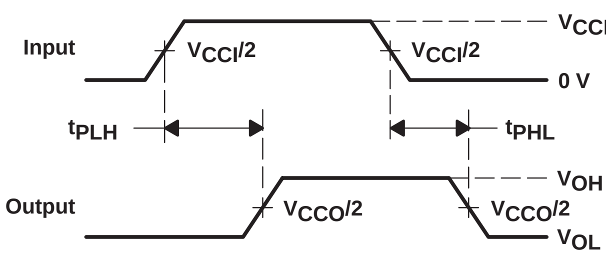
LOAD CIRCUIT

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

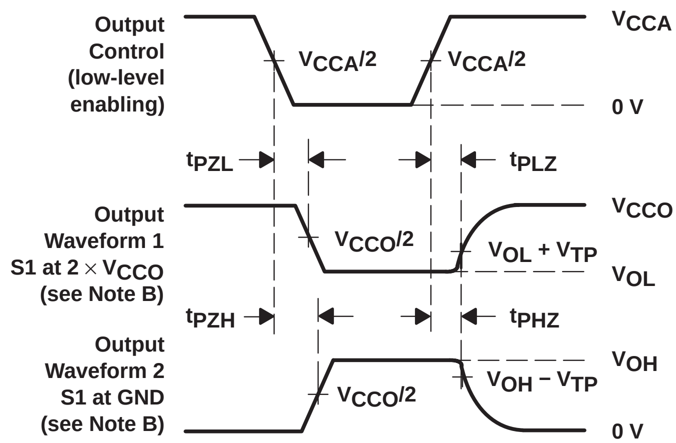
V_{CCO}	C_L	R_L	V_{TP}
1.2 V	15 pF	2 kΩ	0.1 V
1.5 V ± 0.1 V	15 pF	2 kΩ	0.1 V
1.8 V ± 0.15 V	15 pF	2 kΩ	0.15 V
2.5 V ± 0.2 V	15 pF	2 kΩ	0.15 V
3.3 V ± 0.3 V	15 pF	2 kΩ	0.3 V



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

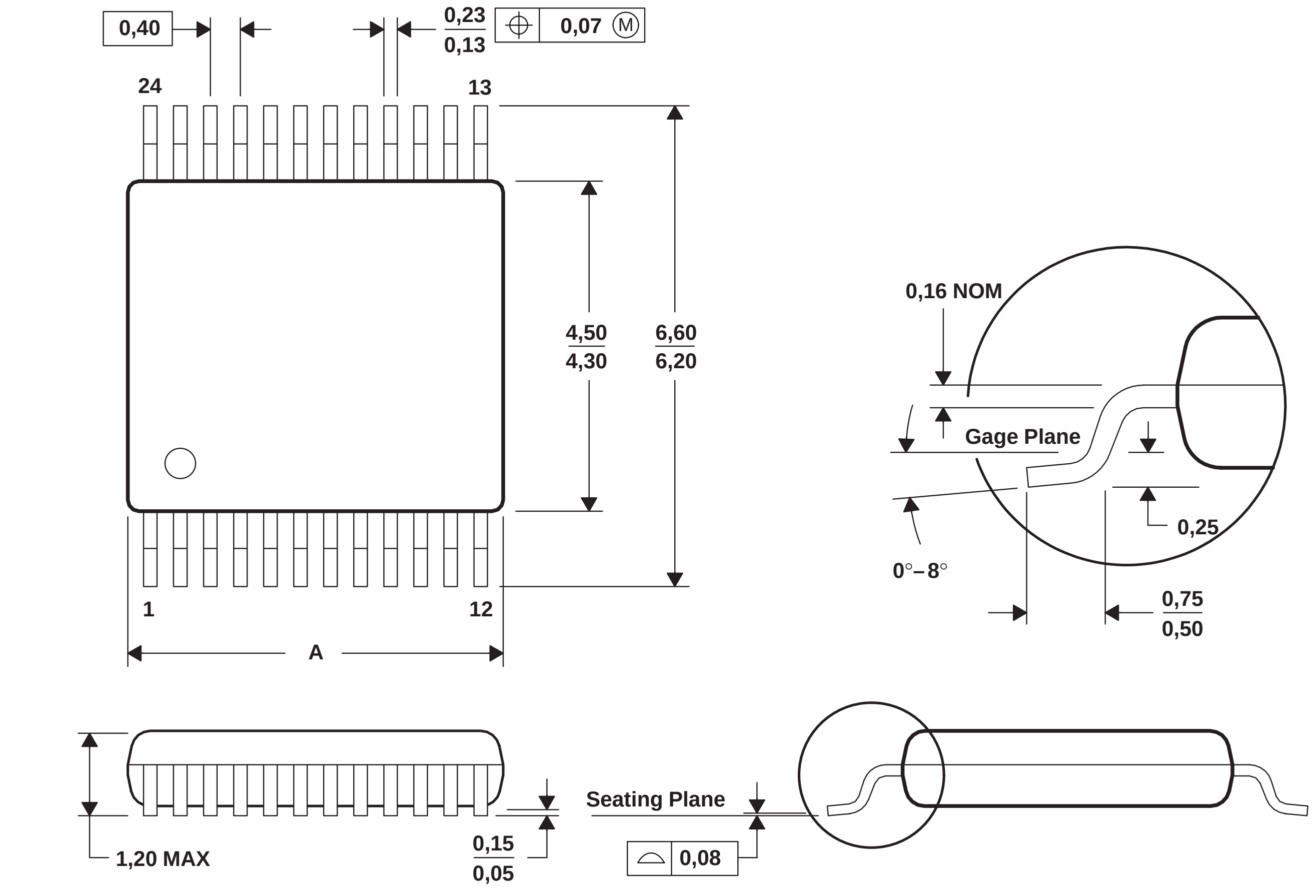
PRODUCT PREVIEW

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, 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.

Figure 11. Load Circuit and Voltage Waveforms

DGV (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

24 PINS SHOWN

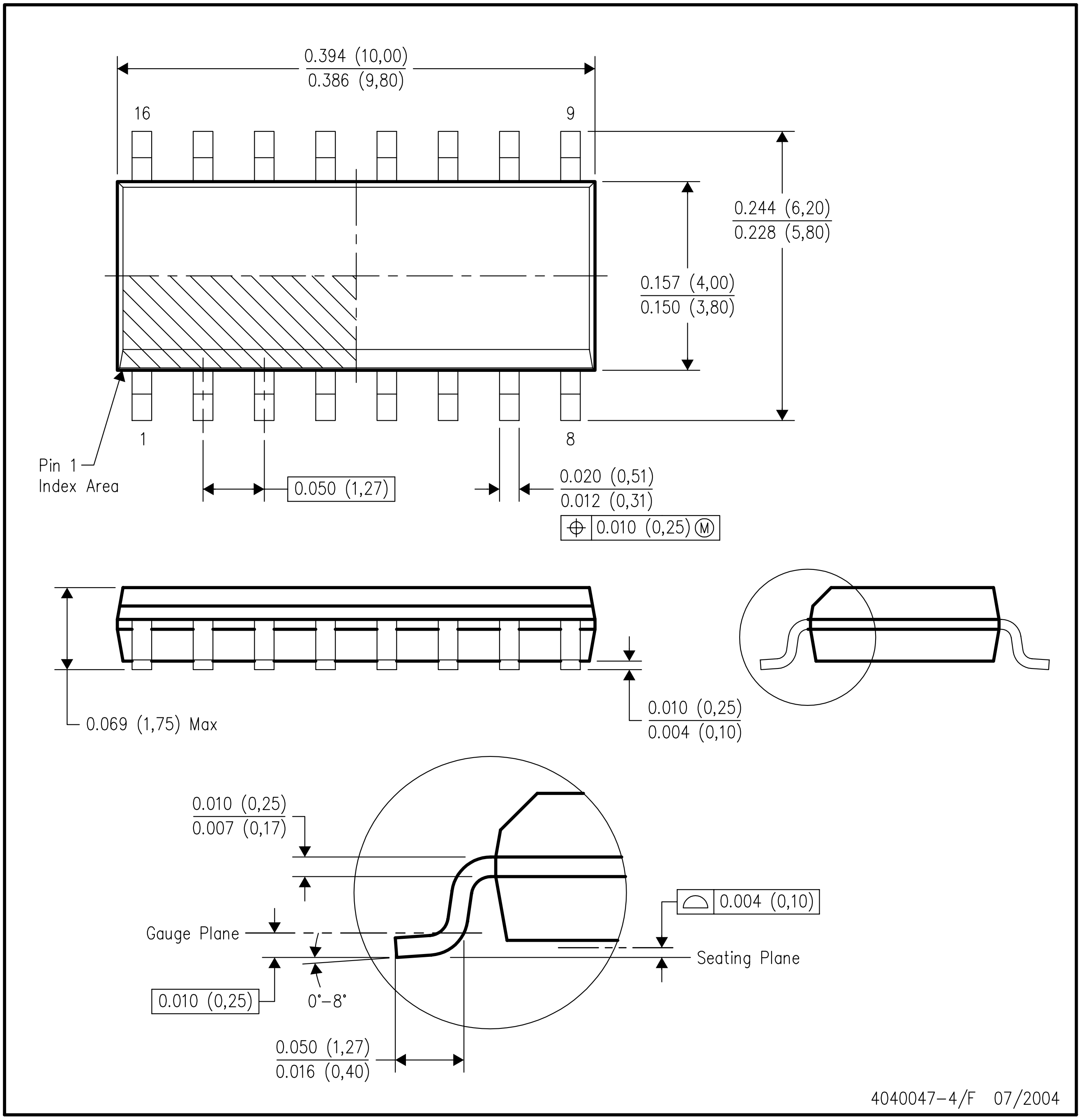


PINS ** / DIM	14	16	20	24	38	48	56
A MAX	3,70	3,70	5,10	5,10	7,90	9,80	11,40
A MIN	3,50	3,50	4,90	4,90	7,70	9,60	11,20

4073251/E 08/00

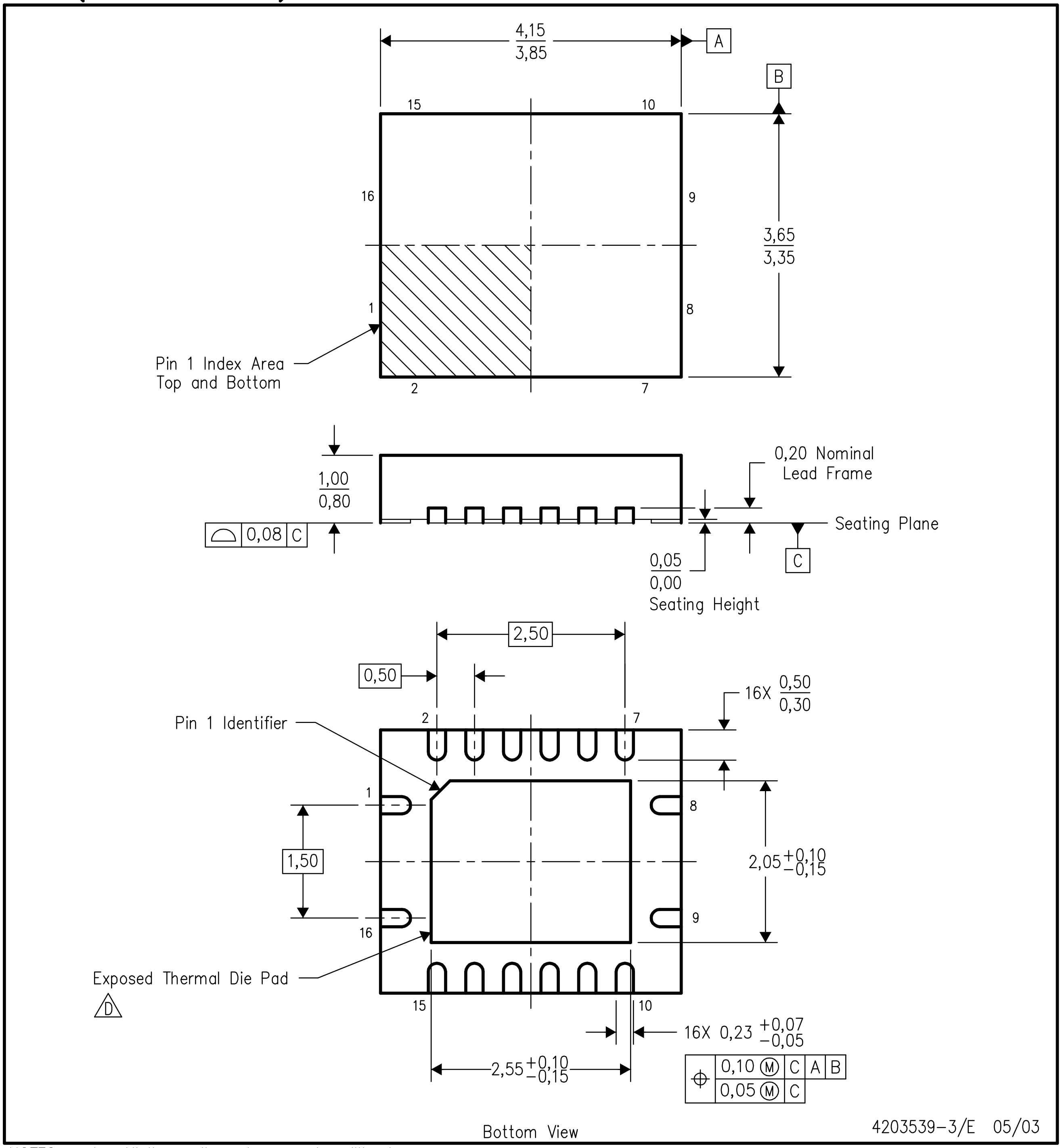
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
D. Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

D (R–PDSO–G16) 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).
D. Falls within JEDEC MS–012 variation AC.

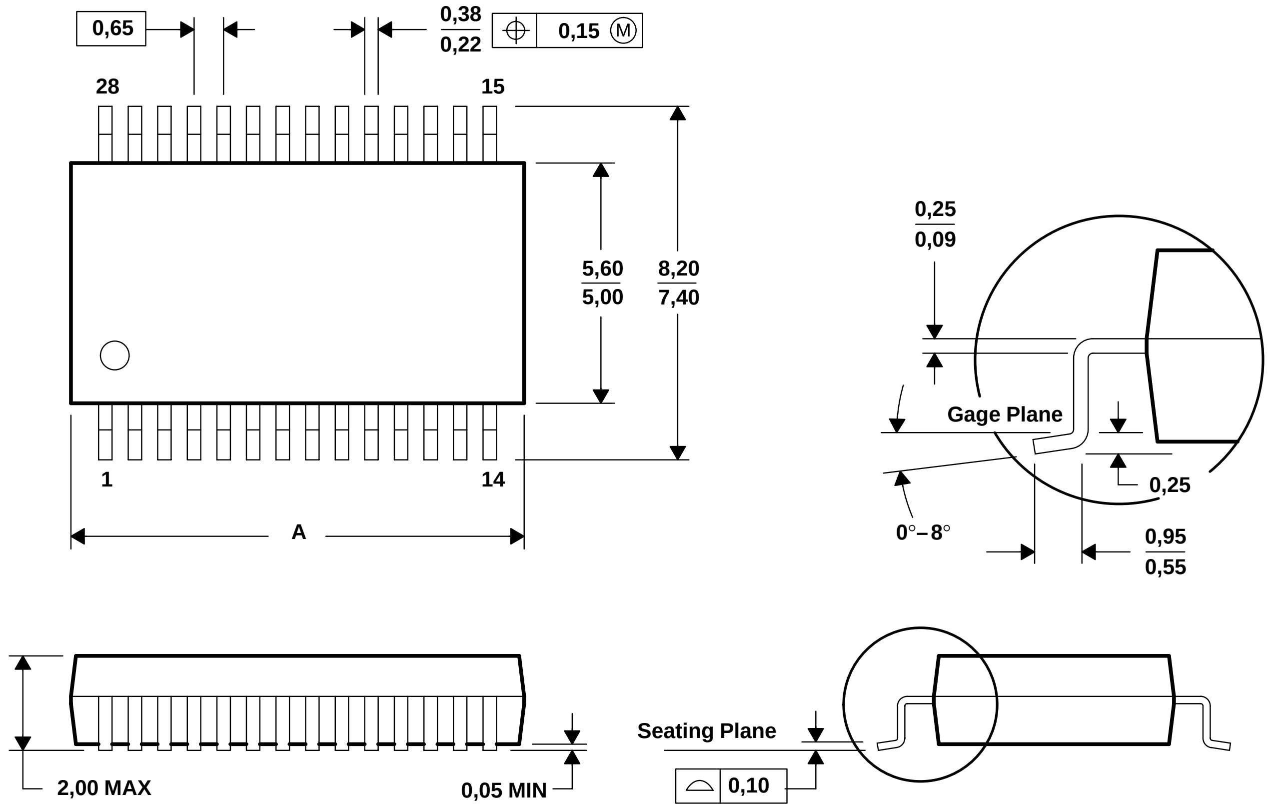
RGY (R–PQFP–N16) PLASTIC QUAD FLATPACK



NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. QFN (Quad Flatpack No-Lead) package configuration.
- D. The package thermal performance may be enhanced by bonding the thermal die pad to an external thermal plane. This pad is electrically and thermally connected to the backside of the die and possibly selected ground leads.
- E. Package complies to JEDEC MO-241 variation BB.

DB (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

28 PINS SHOWN



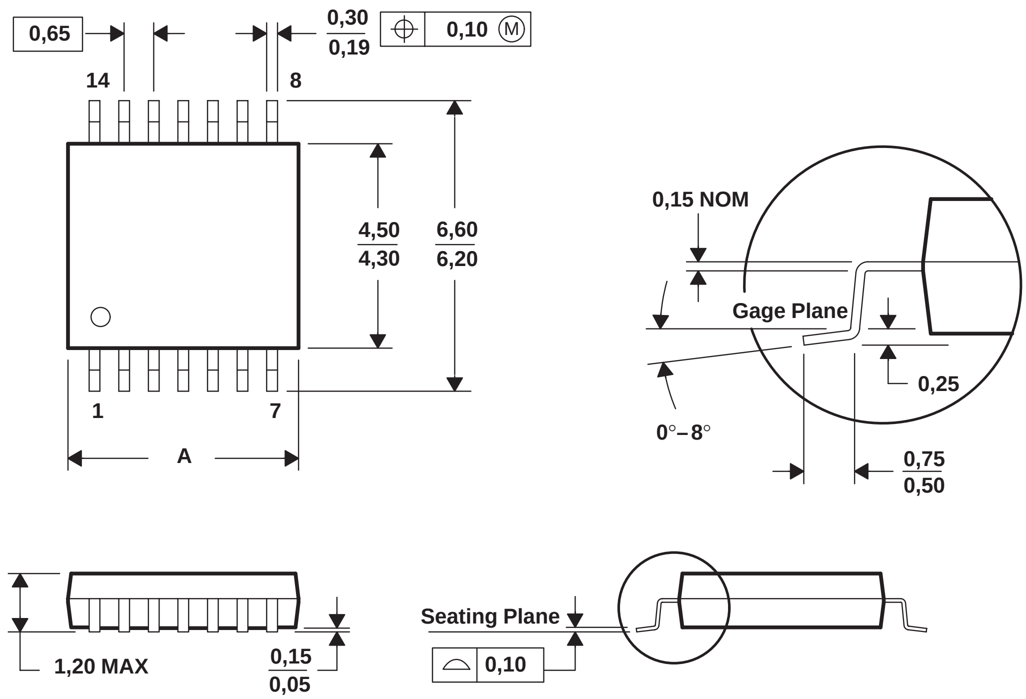
DIM \ PINS **	14	16	20	24	28	30	38
A MAX	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 /E 12/01

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 not to exceed 0,15.
- D. Falls within JEDEC MO-150

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



PINS ** / DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

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 not to exceed 0,15.
- D. Falls within JEDEC MO-153