Description

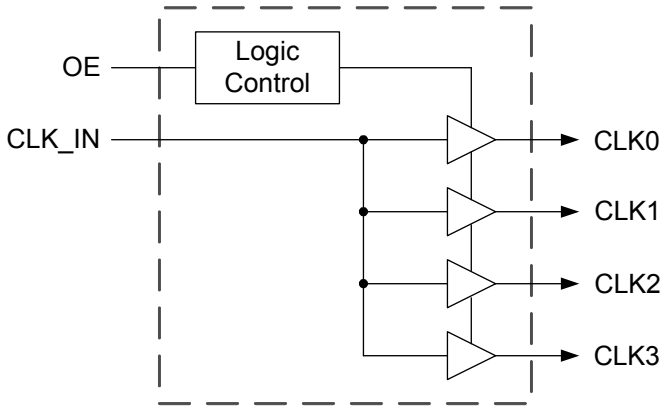
The 2304NZL is a high-performance, low skew, low jitter 1:4 LVCMOS clock buffer. The 2304NZL is ideal for PCI/PCI-X or networking applications.

The 2304NZL supports a synchronous glitch-free Output Enable function to eliminate any potential intermediate incorrect output clock cycles when enabling or disabling outputs.

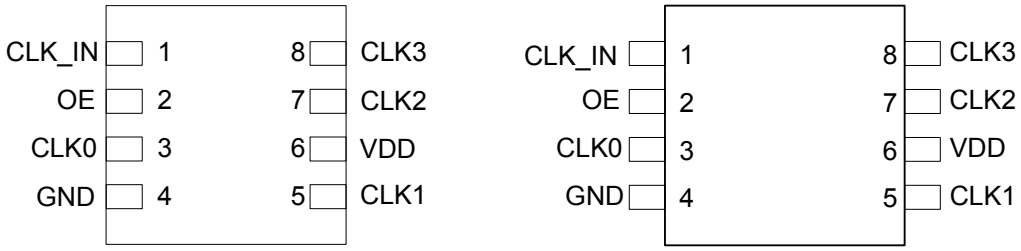
Features

- Low input to output propagation delay (1.8ns, 3.3V)
- Low output skew: 40ps max
- Glitch-free Output Enable Function
- 1.8V to 3.3V power supply
- Packaged in small 8-pin 2mm x 2mm DFN package, as well as standard TSSOP and SOIC packages
- Industrial temperature range (-40°C to +85°C)

Block Diagram



Pin Assignment



8-pin DFN

8-pin TSSOP/SOIC

Functionality Table

Inputs		Outputs
CLK_IN	**OE**	**CLK(3:0)**
0	0	Low
0	1	0
1	0	Low
1	1	1

Pin Descriptions

Pin Number	Pin Name	Pin Type	Pin Description
1	CLK_IN	Input	Clock input.
2	OE	Input	Output Enable for the clock outputs. Outputs are enabled when forced HIGH. Outputs are forced to logic LOW when OE is forced LOW.
3	CLK0	Output	Clock output 0.
4	GND	Power	Power supply ground.
5	CLK1	Output	Clock output 1.
6	VDD	Power	Connect +1.8V, +2.5V or +3.3V power supply.
7	CLK2	Output	Clock output 2.
8	CLK3	Output	Clock output 3.

External Components

A minimum number of external components are required for proper operation. A decoupling capacitor of 0.01µF should be connected between VDD on pin 6 and GND on pin 4, as close to the device as possible. A termination resistor should be used on each clock output if the trace is longer than 1 inch. See the Test Loads section for recommended values.

To achieve the low output skew that the 2304NZL is capable of, careful attention must be paid to board layout. Essentially, all four outputs must have identical terminations, identical loads and identical trace geometries. If they do not, the output skew will be degraded.

Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the 2304NZL. These ratings, which are standard values for IDT commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

Item	Symbol	Conditions	Min.	Typ.	Max.	Units
Supply Voltage	VDD	Power supply			4.6	V
Output Enable and All Outputs	VIO	With respect to GND	-0.5		VDD+0.5	V
ICLK	VIN	Input Voltage	-0.5		4.6	V
Ambient Operating Temperature	TAMB	Industrial Temperature	-40		85	°C
Storage Temperature	TSTORE	Storage Temperature	-65		150	°C
Junction Temperature	TJ	Junction Temperature			125	°C
Soldering Temperature	TSOLDER	Soldering Temperature			260	°C
ESD	ESD	Human Body Model	2000			V

Recommended Operation Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating Temperature	TAMB	Ambient	-40	25	85	°C
Power Supply Voltage	VDD	With respect to GND	1.7		3.465	V

DC Electrical Characteristics

VDD=1.8 V ±5%, Ambient temperature -40° to +85°C, unless stated otherwise

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating Voltage	VDD		1.71	1.8	1.89	V
Input High Voltage(CLK_IN, OE)	VIH	Note 1	0.8xVDD		3.45	V
Input Low Voltage(CLK_IN, OE)	VIL	Note 1			0.2xVDD	V
Output High Voltage	VOH	IOH = -2 mA	0.9xVDD			V
Output Low Voltage	VOL	IOH = 2 mA			0.1xVDD	V
Operating Supply Current	IDD	No load, 50MHz		8		mA
Nominal Output Impedance	ZO			20		Ω
Input Capacitance	CIN	CLK_IN, OE pin		5		pF

Notes: 1. Nominal switching threshold is VDD/2.

VDD=2.5 V ±5%, Ambient temperature -40° to +85°C, unless stated otherwise

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating Voltage	VDD		2.375	2.5	2.625	V
Input High Voltage(CLK_IN, OE)	VIH	Note 1	0.8xVDD		3.45	V
Input Low Voltage(CLK_IN, OE)	VIL	Note 1			0.2xVDD	V
Output High Voltage	VOH	IOH = -2 mA	0.9xVDD			V
Output Low Voltage	VOL	IOH = 2 mA			0.1xVDD	V
Operating Supply Current	IDD	No load, 50MHz		10		mA
Nominal Output Impedance	ZO			21		Ω
Input Capacitance	CIN	CLK_IN, OE pin		5		pF

Notes: 1. Nominal switching threshold is VDD/2.

VDD=3.3 V ±5%, Ambient temperature -40° to +85°C, unless stated otherwise

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating Voltage	VDD		3.135	3.3	3.465	V
Input High Voltage(CLK_IN, OE)	VIH	Note 1	0.8xVDD		3.45	V
Input Low Voltage(CLK_IN, OE)	VIL	Note 1			0.2xVDD	V
Output High Voltage	VOH	IOH = -2 mA	0.9xVDD			V
Output Low Voltage	VOL	IOH = 2 mA			0.1xVDD	V
Operating Supply Current	IDD	No load, 50MHz		12		mA
Nominal Output Impedance	ZO			25		Ω
Input Capacitance	CIN	CLK_IN, OE pin		5		pF

Notes: 1. Nominal switching threshold is VDD/2.

AC Electrical Characteristics

VDD=1.8V ±5%, Ambient Temperature -40° to +85°C, unless stated otherwise

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Frequency	Fin		0		170	MHz
Output Rise Time	tOR	20% to 80% of VDD, CL=5 pF	0.7	1.1	1.5	ns
Output Fall Time	tOF	80% to 20% of VDD, CL=5 pF	0.7	1.1	1.5	ns
Propagation Delay	Note 1		2.2	2.5	3.2	ns
Additive Phase Jitter, RMS		125MHz		100		fs
Duty Cycle		50% input duty cycle	45		55	%
Output to Output Skew	Note 2	Rising edges at VDD/2		15	40	ps
Device to Device Skew		Rising edges at VDD/2			500	ps

VDD=2.5V ±5%, Ambient Temperature -40° to +85°C, unless stated otherwise

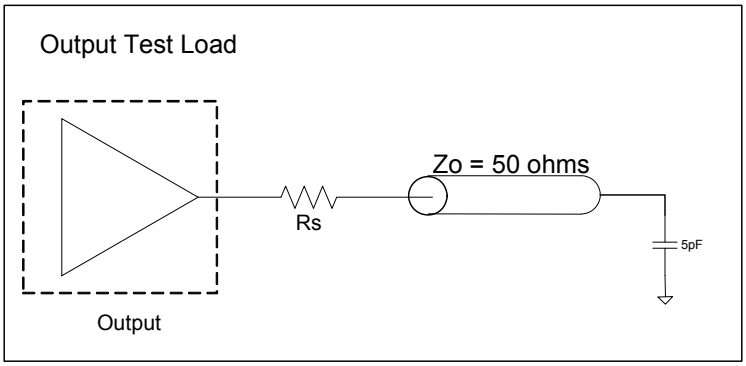
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Frequency	Fin		0		200	MHz
Output Rise Time	tOR	20% to 80% of VDD, CL=5 pF	0.6	1	1.5	ns
Output Fall Time	tOF	80% to 20% of VDD, CL=5 pF	0.6	1	1.5	ns
Propagation Delay	Note 1		1.4	1.9	2.4	ns
Additive Phase Jitter, RMS		125MHz		50		fs
Duty Cycle		50% input duty cycle	45		55	%
Output to Output Skew	Note 2	Rising edges at VDD/2		15	40	ps
Device to Device Skew		Rising edges at VDD/2			500	ps

VDD=3.3 V ±5%, Ambient Temperature -40° to +85°C, unless stated otherwise

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Frequency	Fin		0		200	MHz
Output Rise Time	tOR	20% to 80% of VDD, CL=5 pF	0.5	1	1.5	ns
Output Fall Time	tOF	80% to 20% of VDD, CL=5 pF	0.5	1	1.5	ns
Propagation Delay	Note 1		1.1	1.7	2.1	ns
Additive Phase Jitter, RMS		125MHz		30		fs
Duty Cycle		50% input duty cycle	45		55	%
Output to Output Skew	Note 2	Rising edges at VDD/2		15	40	ps
Device to Device Skew		Rising edges at VDD/2			500	ps

Notes:
1. With rail to rail input clock.
2. Between any 2 outputs with equal loading.
3. Phase noise spec taken with Wenzel oscillator as reference input.

Test Load and Circuit



VDD	Rs (Ω)
1.8V	25
2.5V	29
3.3V	30

Thermal Characteristics (8DFN)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Thermal Resistance Junction to Ambient	θ_{JA}	Still air		81		°C/W
	θ_{JA}	1 m/s air flow		73		°C/W
	θ_{JA}	3 m/s air flow		70		°C/W
Thermal Resistance Junction to Case	θ_{JC}			10.6		°C/W

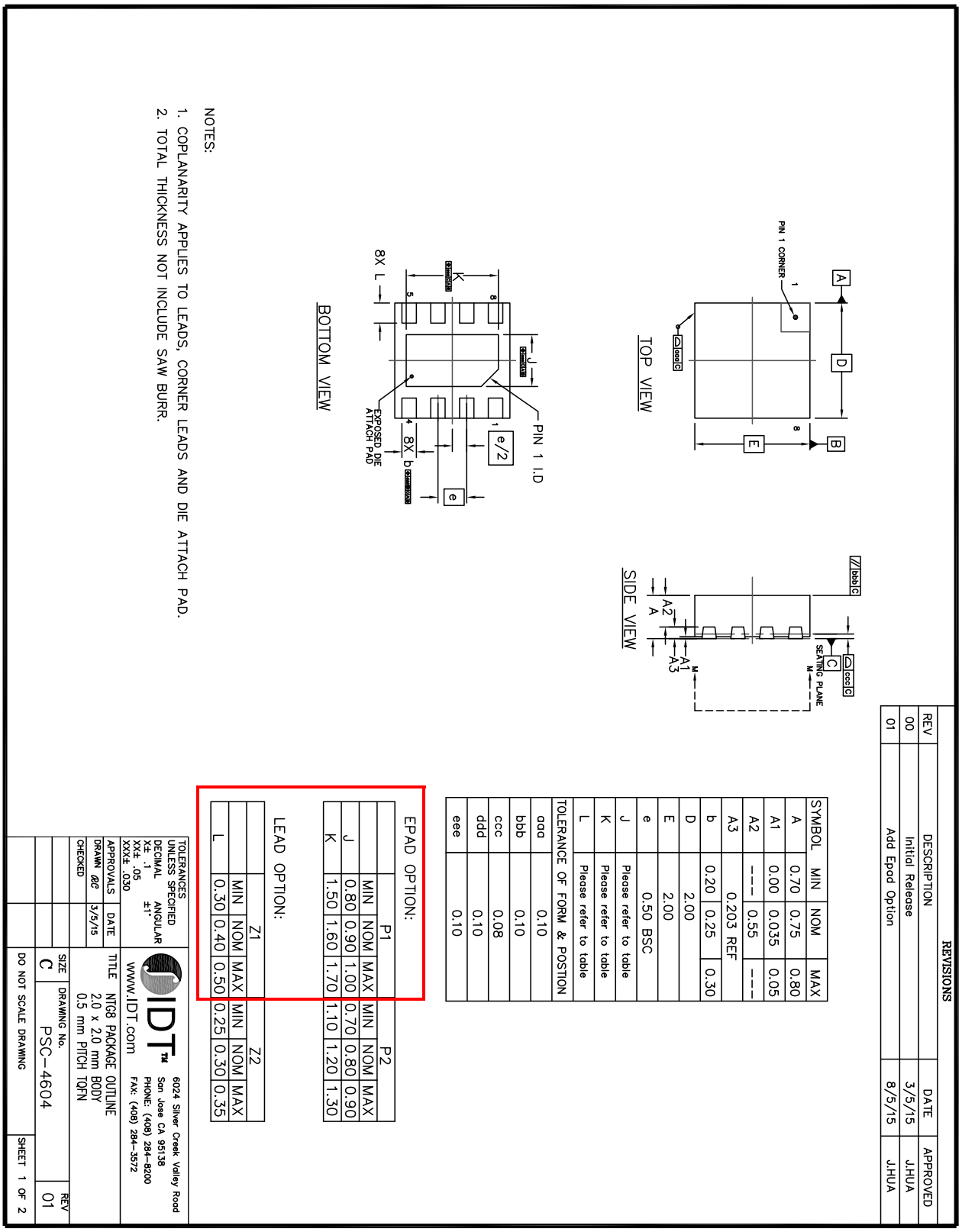
Thermal Characteristics (8TSSOP)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Thermal Resistance Junction to Ambient	θ_{JA}	Still air		110		°C/W
	θ_{JA}	1 m/s air flow		100		°C/W
	θ_{JA}	3 m/s air flow		80		°C/W
Thermal Resistance Junction to Case	θ_{JC}			35		°C/W

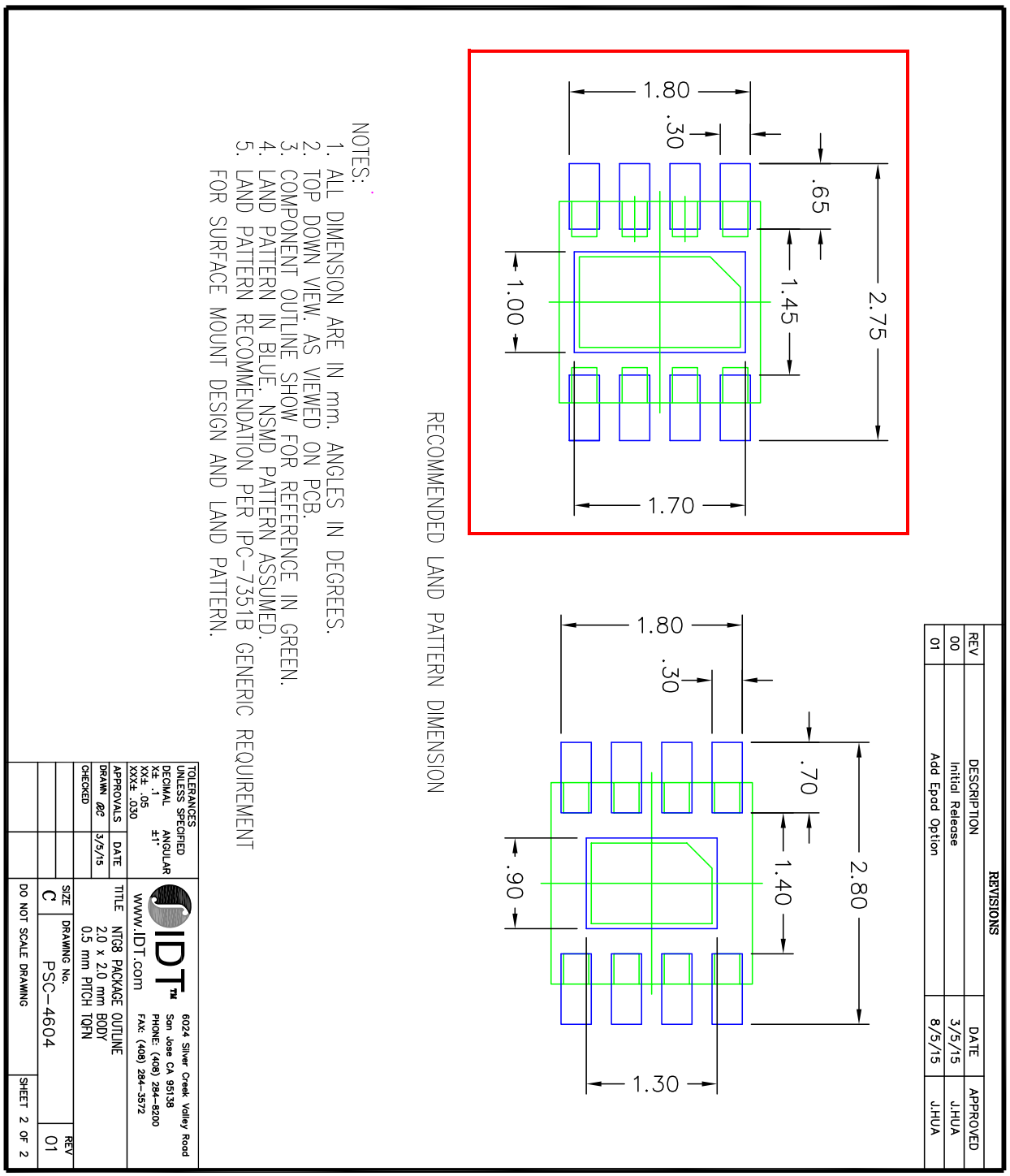
Thermal Characteristics (8SOIC)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Thermal Resistance Junction to Ambient	θ_{JA}	Still air		110		°C/W
	θ_{JA}	1 m/s air flow		100		°C/W
	θ_{JA}	3 m/s air flow		80		°C/W
Thermal Resistance Junction to Case	θ_{JC}			35		°C/W

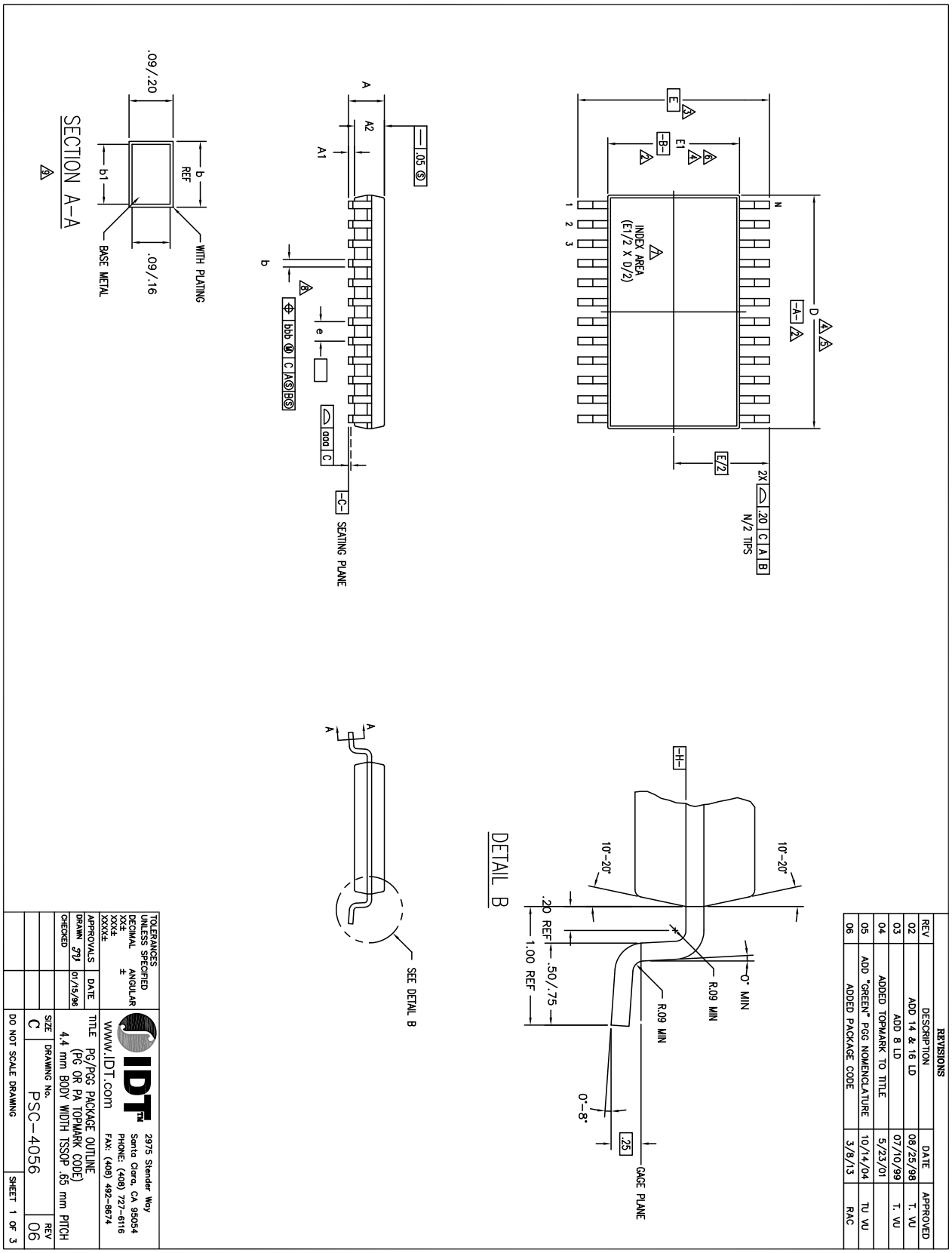
Package Outline and Dimensions (NTG8). Use EPAD P1 and LEAD Z1 options



Package Outline and Dimensions (NTG8), cont.



Package Outline and Dimensions (PGG8)



Package Outline and Dimensions (PGG8), cont.

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
02	ADD 14 & 16 LD	08/25/98	T. VU
03	ADD 8 LD	07/10/99	T. VU
04	ADDED TOPMARK TO TITLE	5/23/01	
05	ADD "GREEN" PGG NOMENCLATURE	10/14/04	TU VU
06	ADDED PACKAGE CODE	3/8/13	RAC

SYMBOL	PG/PGG8 JEDEC VARIATION AA			NOTE	PG/PGG14 JEDEC VARIATION AB–1			NOTE	PG/PGG16 JEDEC VARIATION AB			NOTE	PG/PGG20 JEDEC VARIATION AC			NOTE	PG/PGG24 JEDEC VARIATION AD			NOTE	PG/PGG28 JEDEC VARIATION AE			NOTE
	MIN	NOM	MAX		MIN	NOM	MAX		MIN	NOM	MAX		MIN	NOM	MAX		MIN	NOM	MAX		MIN	NOM	MAX	
A	–	–	1.20		–	–	1.20		–	–	1.20		–	–	1.20		–	–	1.20		–	–	1.20	
A1	.05	–	.15		.05	–	.15		.05	–	.15		.05	–	.15		.05	–	.15		.05	–	.15	
A2	.80	1.00	1.05		.80	1.00	1.05		.80	1.00	1.05		.80	1.00	1.05		.80	1.00	1.05		.80	1.00	1.05	
D	2.90	3.00	3.10	4,5	4.90	5.00	5.10	4,5	4.90	5.00	5.10	4,5	6.40	6.50	6.60	4,5	7.70	7.80	7.90	4,5	9.60	9.70	9.80	4,5
E	6.40 BSC			3	6.40 BSC			3	6.40 BSC			3	6.40 BSC			3	6.40 BSC			3	6.40 BSC			3
E1	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6
e	.65 BSC				.65 BSC				.65 BSC				.65 BSC				.65 BSC				.65 BSC			
b	.19	–	.30		.19	–	.30		.19	–	.30		.19	–	.30		.19	–	.30		.19	–	.30	
b1	.19	.22	.25		.19	.22	.25		.19	.22	.25		.19	.22	.25		.19	.22	.25		.19	.22	.25	
aaa	–	–	.10		–	–	.10		–	–	.10		–	–	.10		–	–	.10		–	–	.10	
bbb	–	–	.10		–	–	.10		–	–	.10		–	–	.10		–	–	.10		–	–	.10	
N	8				14				16				20				24				28			

NOTES:

1 ALL DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M–1994

2 DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-

3 DIMENSION E TO BE DETERMINED AT SEATING PLANE -C-

4 DIMENSIONS D AND E1 ARE TO BE DETERMINED AT DATUM PLANE -H-

5 DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED .15 mm PER SIDE

6 DIMENSION E1 DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED .25 mm PER SIDE

7 DETAIL OF PIN 1 IDENTIFIER IS OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED

8 LEAD WIDTH DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION IS .08 mm IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT

9 THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .10 AND .25 mm FROM THE LEAD TIP

10 ALL DIMENSIONS ARE IN MILLIMETERS

11 THIS OUTLINE CONFORMS TO JEDEC PUBLICATION 95 REGISTRATION MO–153, VARIATION AA, AB–1, AB, AC, AD & AE

TOLERANCES UNLESS SPECIFIED
DECIMAL XX± XXX± XXXX±
ANGULAR ±

APPROVALS	DATE
DRAWN TU	01/15/96
CHECKED	

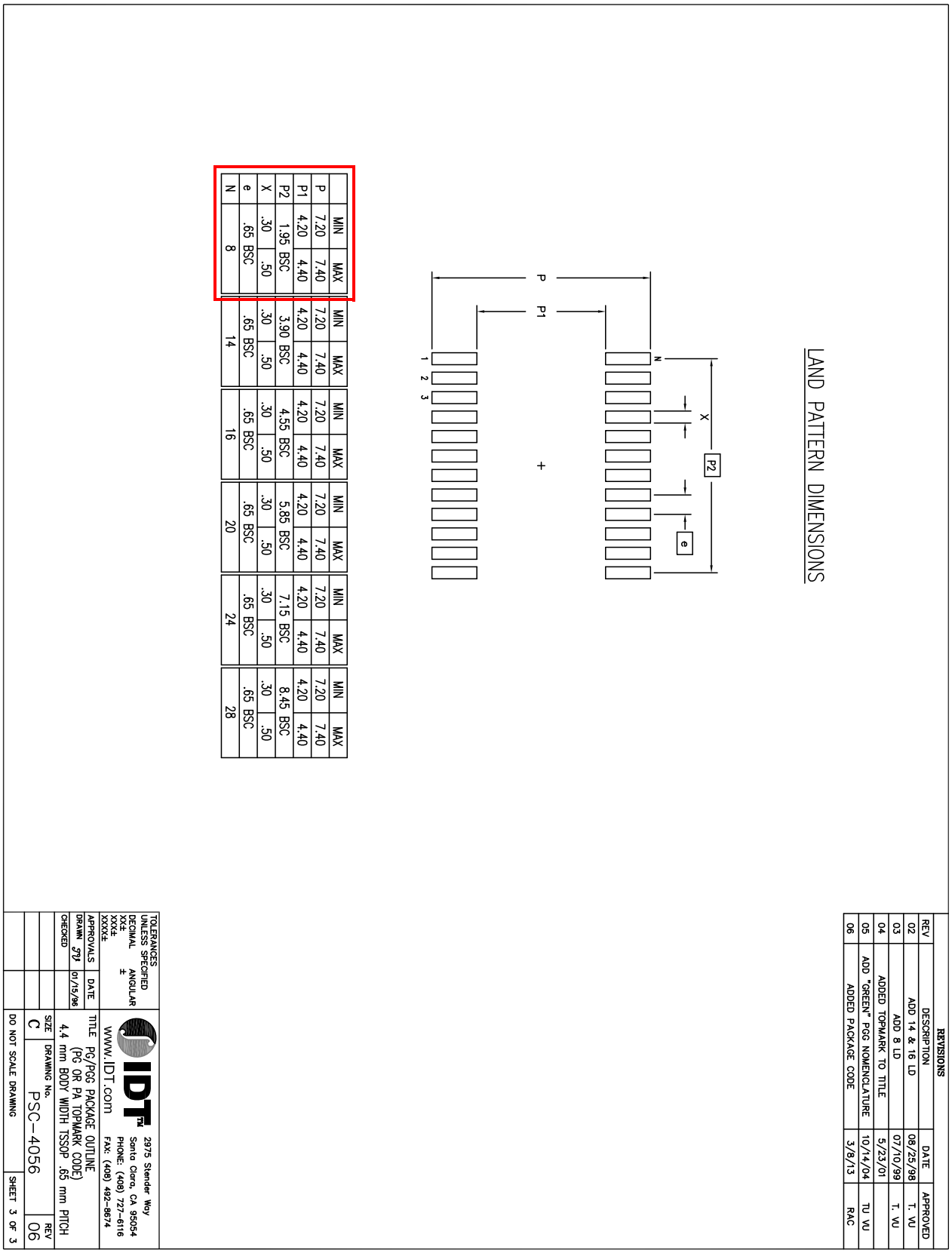
IDT™ www.IDT.com
2975 Stender Way
Santa Clara, CA 95054
PHONE: (408) 727–6116
FAX: (408) 492–8674

TITLE PG/PGG PACKAGE OUTLINE (PG OR PA TOPMARK CODE) 4.4 mm BODY WIDTH TSSOP .65 mm PITCH

SIZE C | DRAWING No. PSC–4056 | REV 06

DO NOT SCALE DRAWING | SHEET 2 OF 3

Package Outline and Dimensions (PGG8), cont.



	8		14		16		20		24		28	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
P	7.20	7.40	7.20	7.40	7.20	7.40	7.20	7.40	7.20	7.40	7.20	7.40
P1	4.20	4.40	4.20	4.40	4.20	4.40	4.20	4.40	4.20	4.40	4.20	4.40
P2	1.95 BSC		3.90 BSC		4.55 BSC		5.85 BSC		7.15 BSC		8.45 BSC	
X	.30	.50	.30	.50	.30	.50	.30	.50	.30	.50	.30	.50
e	.65 BSC		.65 BSC		.65 BSC		.65 BSC		.65 BSC		.65 BSC	
N	8		14		16		20		24		28	

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
02	ADD 14 & 16 LD	08/25/98	T. VU
03	ADD 8 LD	07/10/99	T. VU
04	ADDED TOPMARK TO TITLE	5/23/01	
05	ADD "GREEN" PGG NOMENCLATURE	10/14/04	TU VU
06	ADDED PACKAGE CODE	3/8/13	RAC

TOLERANCES UNLESS SPECIFIED
DECIMAL ANGULAR
XX± ±
XXX±
XXXX±

APPROVALS DATE
DRAWN 571 01/15/96
CHECKED

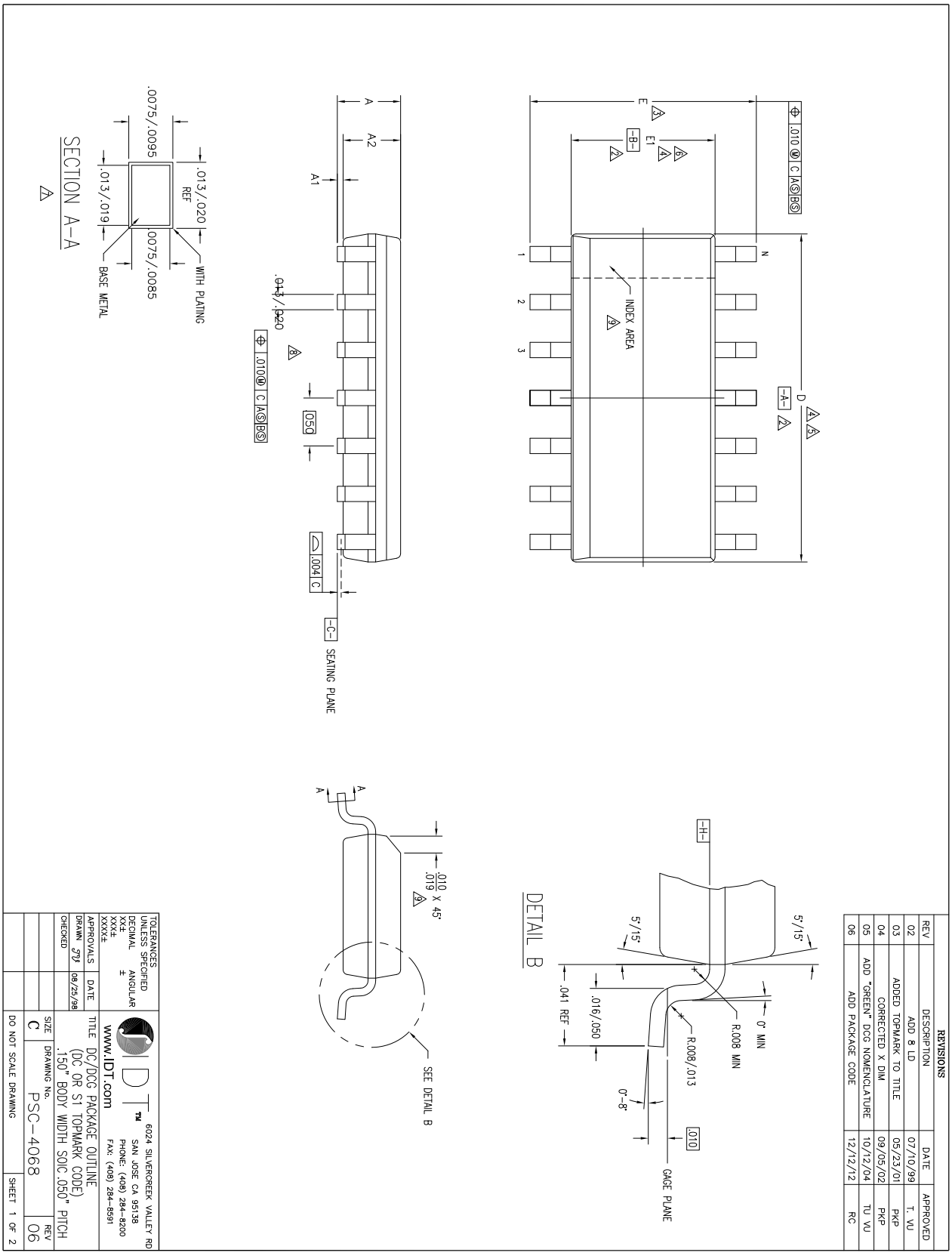
IDT™ 2975 Stender Way Santa Clara, CA 95054 PHONE: (408) 727-6116 FAX: (408) 492-8674
WWW.IDT.com

TITLE PG/PGG PACKAGE OUTLINE (PG OR PA TOPMARK CODE) 4.4 mm BODY WIDTH TSSOP .65 mm PITCH

SIZE C DRAWING No. PSC-4056 REV 06

DO NOT SCALE DRAWING SHEET 3 OF 3

Package Outline and Dimensions (DCG8)



Package Outline and Dimensions (DCG8), cont.

SYMBOL	DC/DCG8 JEDEC VARIATION AA			NOTE	DC/DCG14 JEDEC VARIATION AB			NOTE	DC/DCG16 JEDEC VARIATION AC			NOTE
	MIN	NOM	MAX		MIN	NOM	MAX		MIN	NOM	MAX	
A	.053	.064	.068		.053	.064	.068		.053	.064	.068	
A1	.004	.006	.010		.004	.006	.010		.004	.006	.010	
A2	.055	.058	.061	11	.055	.058	.061	11	.055	.058	.061	11
D	.189	.194	.197	4,5	.337	.342	.344	4,5	.386	.391	.393	4,5
E	.230	.236	.244	3	.230	.236	.244	3	.230	.236	.244	3
E1	.150	.155	.157	4,6	.150	.155	.157	4,6	.150	.155	.157	4,6
N	8				14				16			

NOTES:

1. ALL DIMENSIONING AND TOLERANCING CONFORM TO ANSI Y14.5M-1982
2. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-
3. DIMENSION E TO BE DETERMINED AT SEATING PLANE -C-
4. DIMENSIONS D AND E1 ARE TO BE DETERMINED AT DATUM PLANE -H-
5. DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED .006 PER SIDE
6. DIMENSION E1 DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 PER SIDE
7. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 AND .010 FROM LEAD TIP
8. LEAD WIDTH DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION IS .004 IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT
9. THE CHAMFER ON THE PACKAGE BODY IS OPTIONAL. IF IT IS NOT PRESENT, A VISUAL INDEX FEATURE MUST BE LOCATED WITHIN THE ZONE INDICATED
10. ALL DIMENSIONS ARE IN INCHES
11. THIS OUTLINE CONFORMS TO JEDEC PUBLICATION 95 REGISTRATION MS-012, VARIATION AA, AB & AC

LAND PATTERN DIMENSIONS

	MIN	MAX	MIN	MAX	MIN	MAX
P	.274	.282	.274	.282	.274	.282
P1	.142	.150	.142	.150	.142	.150
P2	.150 BSC		.300 BSC		.350 BSC	
X	.015	.024	.015	.024	.015	.024
e	.050 BSC		.050 BSC		.050 BSC	
N	8		14		16	

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
02	ADD 8 LD	07/10/99	T. VU
03	ADDED TOPMARK TO TITLE	05/23/01	PKP
04	CORRECTED X DIM	09/05/02	PKP
05	ADD "GREEN" DCG NOMENCLATURE	10/12/04	TU VU
06	ADD PACKAGE CODE	12/12/12	RC

TOLERANCES UNLESS SPECIFIED
DECIMAL ANGULAR
XX± ±
XXX± XXXX±
APPROVALS DATE
DRAWN 07/1 06/25/98
CHECKED

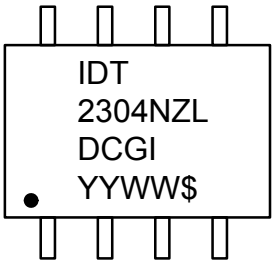
IDT™ 6024 SILVERCREEK VALLEY RD SAN JOSE CA 95138 PHONE: (408) 284-8200 FAX: (408) 284-8591 www.IDT.com

TITLE DC/DCG PACKAGE OUTLINE (DC OR S1 TOPMARK CODE) .150" BODY WIDTH SOIC .050" PITCH

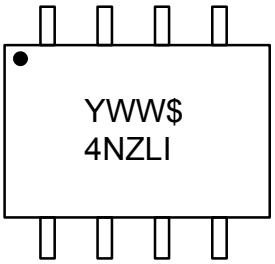
SIZE C | DRAWING No. PSC-4068 | REV 06

DO NOT SCALE DRAWING | SHEET 2 OF 2

Marking Diagrams



8-pin SOIC



8-pin TSSOP

8-pin DFN

Notes:

1. "**" is the lot number (DFN only).
2. "YYWW" or "YWW" or "YW" is the digits of the year and week that the part was assembled.
3. "$" is the mark code.
4 "G" denotes RoHS compliant package.
5. "I" denotes industrial temperature range.
6. Bottom markings: lot number and country of origin for TSSOP; lot number for SOIC.

Ordering Information

Part / Order Number	Shipping Packaging	Package	Temperature
2304NZLDCGI	Tubes	8-pin SOIC	-40 to +85°
2304NZLDCGI8	Tape and Reel	8-pin SOIC	-40 to +85°
2304NZLPGGI	Tubes	8-pin TSSOP	-40 to +85°
2304NZLPGGI8	Tape and Reel	8-pin TSSOP	-40 to +85°
2304NZLNTGI	Tubes	8-pin DFN	-40 to +85°
2304NZLNTGI8	Tape and Reel	8-pin DFN	-40 to +85°

"G" after the two-letter package code denotes Pb-Free configuration, RoHS compliant.

Revision History

Rev.	Date	Originator	Description of Change
A	06/21/16	H.G.	1. Added marking diagrams. 2. Moved to final.
B	01/31/17	Y.G.	1. Updates to operating supply current and output impedance values in DC electrical tables. 2. Added Rs values to test loads.

Corporate Headquarters
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(Rev.1.0 Mar 2020)

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