

CMOS Presettable Up/Down Counter

Binary or BCD-Decade

High-Voltage Types (20-Volt Rating)

■ CD4029B consists of a four-stage binary or BCD-decade up/down counter with provisions for look-ahead carry in both counting modes. The inputs consist of a single **CLOCK**, **CARRY-IN (CLOCK ENABLE)**, **BINARY/DECADE**, **UP/DOWN**, **PRESET ENABLE**, and four individual **JAM** signals. **Q1**, **Q2**, **Q3**, **Q4** and a **CARRY OUT** signal are provided as outputs.

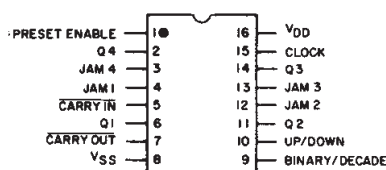
A high **PRESET ENABLE** signal allows information on the **JAM INPUTS** to preset the counter to any state asynchronously with the clock. A low on each **JAM** line, when the **PRESET-ENABLE** signal is high, resets the counter to its zero count. The counter is advanced one count at the positive transition of the clock when the **CARRY-IN** and **PRESET ENABLE** signals are low. Advancement is inhibited when the **CARRY-IN** or **PRESET ENABLE** signals are high. The **CARRY-OUT** signal is normally high and goes low when the counter reaches its maximum count in the **UP** mode or the minimum count in the **DOWN** mode provided the **CARRY-IN** signal is low. The **CARRY-IN** signal in the low state can thus be considered a **CLOCK ENABLE**. The **CARRY-IN** terminal must be connected to **V_{SS}** when not in use.

Binary counting is accomplished when the **BINARY/DECADE** input is high; the counter counts in the decade mode when the **BINARY/DECADE** input is low. The counter counts up when the **UP/DOWN** input is high, and down when the **UP/DOWN** input is low. Multiple packages can be connected in either a parallel-clocking or a ripple-clocking arrangement as shown in Fig. 17.

Parallel clocking provides synchronous control and hence faster response from all counting outputs. Ripple-clocking allows for longer clock input rise and fall times.

The CD4029B-series types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (M, M96, MT, and NSR suffixes), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).

CD4029B Terminal Diagram



92CS-24472R1

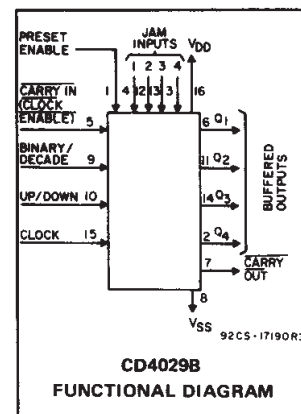
CD4029B Types

Features:

- Medium-speed operation . . . 8 MHz (typ.)
@ $C_L = 50$ pF and $V_{DD} - V_{SS} = 10$ V
- Multi-package parallel clocking for synchronous high speed output response or ripple clocking for slow clock input rise and fall times
- "Preset Enable" and individual "Jam" inputs provided
- Binary or decade up/down counting
- BCD outputs in decade mode
- 100% tested for quiescent current at 20 V
- 5-V, 10-V, and 15-V parametric ratings
- Standardized, symmetrical output characteristics
- Maximum input current of $1 \mu A$ at 18 V over full package-temperature range; 100 nA at 18 V and 25°C
- Noise margin (over full package-temperature range)
 - 1 V at $V_{DD} = 5$ V
 - 2 V at $V_{DD} = 10$ V
 - 2.5 V at $V_{DD} = 15$ V
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

Applications:

- Programmable binary and decade counting/frequency synthesizers-BCD output
- Analog to digital and digital to analog conversion
- Up/Down binary counting
- Magnitude and sign generation
- Up/Down decade counting
- Difference counting



RECOMMENDED OPERATING CONDITIONS at $T_A = 25^\circ C$, Except as Noted. For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTIC	V _{DD} (V)	LIMITS		UNITS
		Min.	Max.	
Supply-Voltage Range (For $T_A =$ Full Package-Temperature Range)	—	3	18	V
Setup Time t_{SU} : Carry-In	5	200	—	ns
	10	70	—	
	15	60	—	
U/D or B/D	5	340	—	
	10	140	—	
	15	100	—	
Clock Pulse Width, t_W	5	180	—	ns
	10	90	—	
	15	60	—	
Preset Enable Pulse Width, t_W	5	130	—	
	10	70	—	
	15	50	—	
Clock Input Frequency, f_{CL}	5	—	2	MHz
	10	—	4	
	15	—	5.5	
Clock Rise and Fall Time, t_{rCL} , t_{fCL}	5	—	—	μs
	10	—	15	
	15	—	—	

CD4029B Types

MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, (V_{DD})	Voltages referenced to V_{SS} Terminal)	-0.5V to +20V
INPUT VOLTAGE RANGE, ALL INPUTS		-0.5V to $V_{DD} + 0.5V$
DC INPUT CURRENT, ANY ONE INPUT		$\pm 10mA$
POWER DISSIPATION PER PACKAGE (P_D):		
For $T_A = -55^{\circ}C$ to $+100^{\circ}C$		500mW
For $T_A = +100^{\circ}C$ to $+125^{\circ}C$		Derate Linearly at 12mW/ $^{\circ}C$ to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR		
FOR $T_A =$ FULL PACKAGE-TEMPERATURE RANGE (All Package Types)		100mW
OPERATING-TEMPERATURE RANGE (T_A)		$-55^{\circ}C$ to $+125^{\circ}C$
STORAGE TEMPERATURE RANGE (T_{stg})		$-65^{\circ}C$ to $+150^{\circ}C$
LEAD TEMPERATURE (DURING SOLDERING):		
At distance $1/16 \pm 1/32$ inch ($1.59 \pm 0.79mm$) from case for 10s max		$+265^{\circ}C$

STATIC ELECTRICAL CHARACTERISTICS

CHARAC- TERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V _O (V)	V _{IN} (V)	V _{DD} (V)	-55	-40	+85	+125	+25			
								Min.	Typ.	Max.	
Quiescent Device Current, I _{DD} Max.	—	0,5	5	5	5	150	150	—	0.04	5	μA
	—	0,10	10	10	10	300	300	—	0.04	10	
	—	0,15	15	20	20	600	600	—	0.04	20	
	—	0,20	20	100	100	3000	3000	—	0.08	100	
Output Low (Sink) Current I _{OL} Min.	0.4	0,5	5	0.64	0.61	0.42	0.36	0.51	1	—	mA
	0.5	0,10	10	1.6	1.5	1.1	0.9	1.3	2.6	—	
	1.5	0,15	15	4.2	4	2.8	2.4	3.4	6.8	—	
Output High (Source) Current, I _{OH} Min.	4.6	0,5	5	-0.64	-0.61	-0.42	-0.36	-0.51	-1	—	mA
	2.5	0,5	5	-2	-1.8	-1.3	-1.15	-1.6	-3.2	—	
	9.5	0,10	10	-1.6	-1.5	-1.1	-0.9	-1.3	-2.6	—	
	13.5	0,15	15	-4.2	-4	-2.8	-2.4	-3.4	-6.8	—	
Output Voltage: Low-Level, V _{OL} Max.	—	0,5	5	0.05				—	0	0.05	V
	—	0,10	10	0.05				—	0	0.05	
	—	0,15	15	0.05				—	0	0.05	
Output Voltage: High-Level, V _{OH} Min.	—	0,5	5	4.95				4.95	5	—	V
	—	0,10	10	9.95				9.95	10	—	
	—	0,15	15	14.95				14.95	15	—	
Input Low Voltage V _{IL} Max.	0.5,4.5	—	5	1.5				—	—	1.5	V
	1,9	—	10	3				—	—	3	
	1.5,13.5	—	15	4				—	—	4	
Input High Voltage, V _{IH} Min.	0.5,4.5	—	5	3.5				3.5	—	—	V
	1,9	—	10	7				7	—	—	
	1.5,13.5	—	15	11				11	—	—	
Input Current I _{IN} Max.	—	0,18	18	±0.1	±0.1	±1	±1	—	±10 ⁻⁵	±0.1	μA

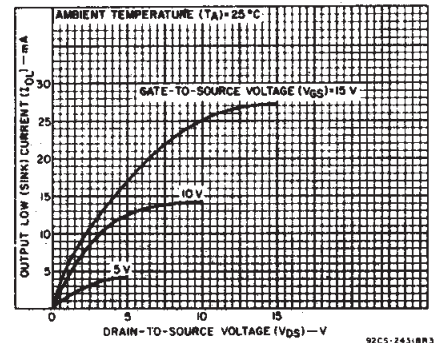


Fig. 1 - Typical output low (sink) current characteristics.

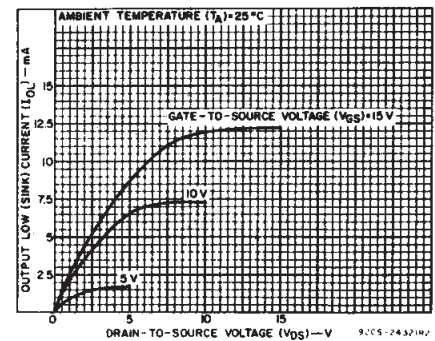


Fig. 2 - Minimum output low (sink) current characteristics.

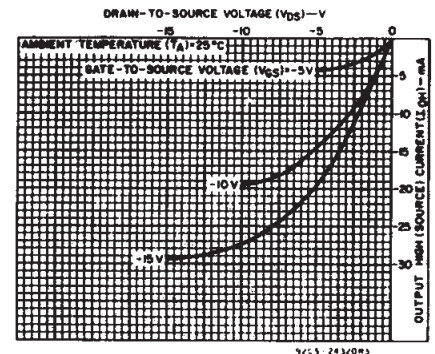


Fig. 3 - Typical output high (source) current characteristics.

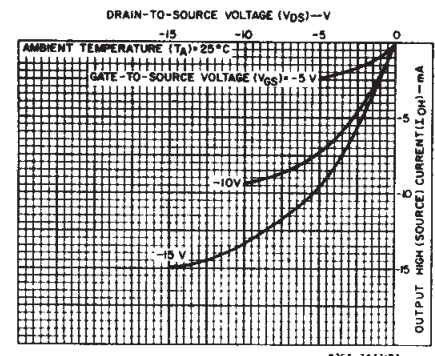


Fig. 4 - Minimum output high (source) current characteristics.

CD4029B Types

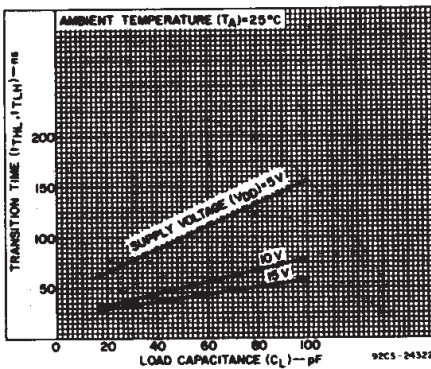


Fig. 5 - Typical transition time as a function of load capacitance.

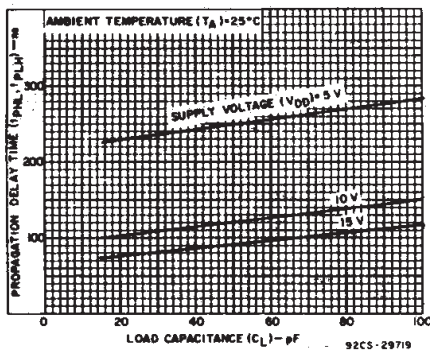


Fig. 6 - Typical propagation delay times as a function of load capacitance (Q output).

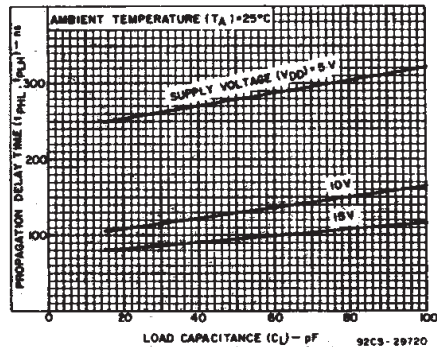


Fig. 7 - Typical propagation delay time as a function of load capacitance (carry output).

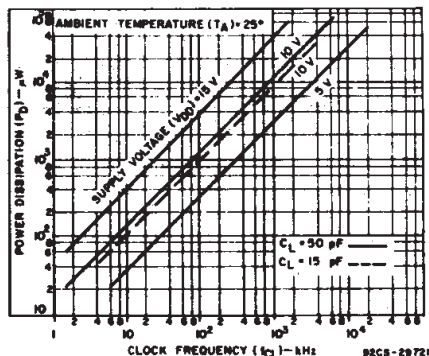


Fig. 8 - Typical power dissipation as a function of frequency.

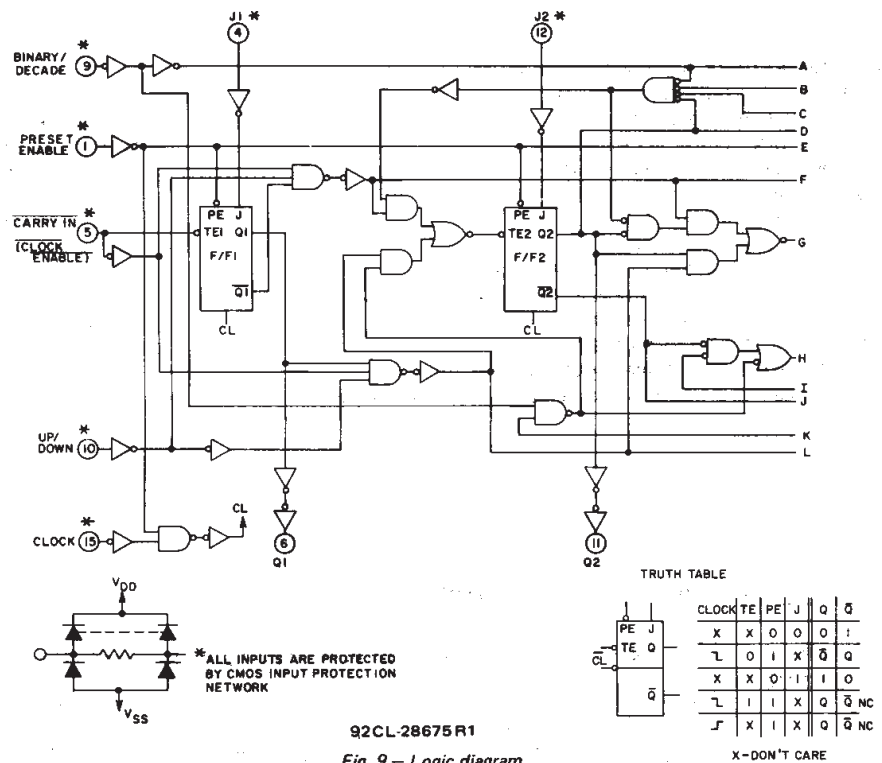


Fig. 9 - Logic diagram.

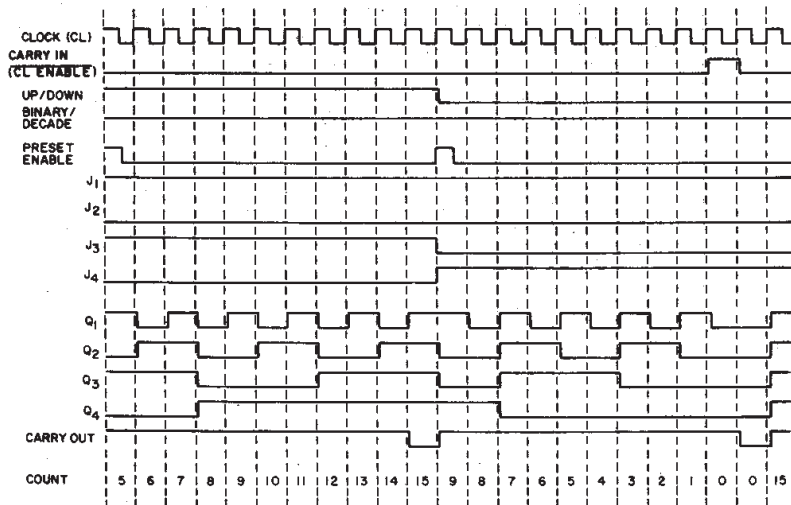


Fig. 10 - Timing diagram-binary mode.

CD4029B Types

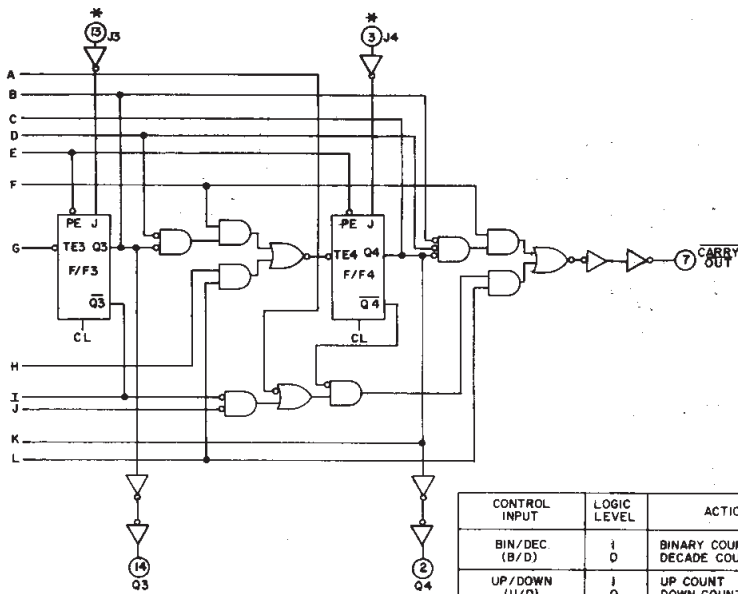
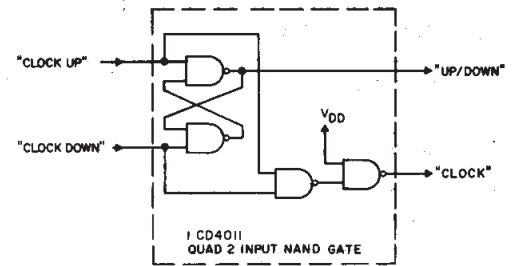


Fig. 9 – Logic diagram (cont'd).

CONTROL INPUT	LOGIC LEVEL	ACTION
BIN/DEC (B/D)	1 0	BINARY COUNT DECADE COUNT
UP/DOWN (U/D)	1 0	UP COUNT DOWN COUNT
PRESET ENABLE (PE)	1 0	JAM IN NO JAM
CARRY IN (C.I.) (CLOCK ENABLE)	1 0	NO COUNTER ADVANCE AT POS. CLOCK TRANSITION ADVANCE COUNTER AT POS. CLOCK TRANSITION

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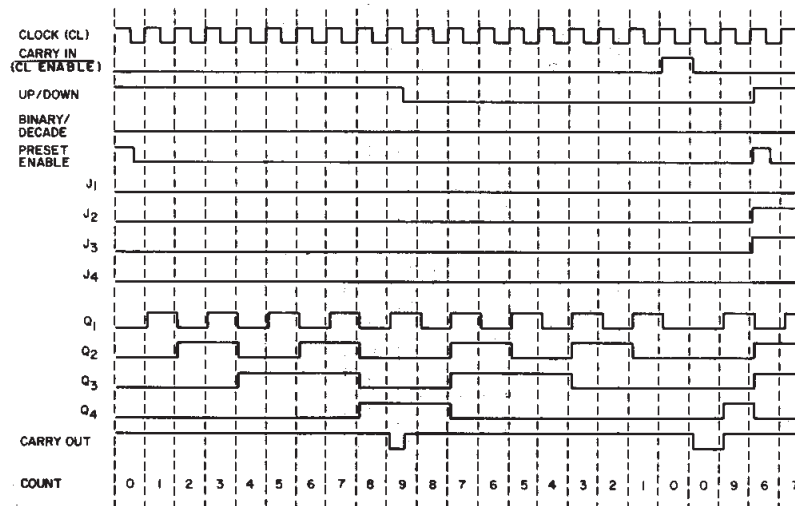


92CS-17195R2

Fig. 11 – Conversion of clock up, clock down input signals to clock and up/down input signals.

The CD4029B CLOCK and UP/DOWN inputs are used directly in most applications. In applications where CLOCK UP and CLOCK DOWN inputs are provided, conversion to the CD4029B CLOCK and UP/DOWN inputs can easily be realized by use of the circuit in Fig. 11.

CD4029B changes count on positive transitions of CLOCK UP or CLOCK DOWN inputs. For the gate configuration shown below, when counting up the CLOCK DOWN input must be maintained high and conversely when counting down the CLOCK UP input must be maintained high.



92CM-17193R3

Fig. 12 – Timing diagram-decade mode.

CD4029B Types

DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ\text{C}$, Input $t_r, t_f = 20\text{ ns}$,
 $C_L = 50\text{ pF}$, $R_L = 200\text{ k}\Omega$

CHARACTERISTIC	TEST CONDITIONS		LIMITS			UNITS	
	V_{DD} (V)	Min.	Typ.	Max.			
Clocked Operation							
Propagation Delay Time: t_{PHL}, t_{PLH} Q Output	Any Input	5	—	250	500	ns	
		10	—	120	240		
		15	—	90	180		
5		—	280	560			
10		—	130	260			
15		—	95	190			
5		—	100	200			
10		—	50	100			
15		—	40	80			
Carry Output		5	—	90	180	μs	
		10	—	45	90		
		15	—	30	60		
Transition Time: Q Outputs, Carry Output		5	—	—	15		ns
		10	—	—	15		
		15	—	—	15		
Minimum Clock Pulse Width, t_W		5	—	170	340		ns
		10	—	70	140		
		15	—	50	100		
Clock Rise & Fall Time, t_{rCL}, t_{fCL}^{**}	5	2	4	—	MHz		
	10	4	8	—			
	15	5.5	11	—			
Minimum Setup Times, t_S^* B/D or U/D							
Maximum Clock Input Frequency, f_{CL}							
Input Capacitance, C_{IN}		—	5	7.5	pF		
Preset Enable							
Propagation Delay Time: t_{PHL}, t_{PLH} Q Outputs	Any Input	5	—	235	470	ns	
		10	—	100	200		
		15	—	80	160		
5		—	320	640			
10		—	145	290			
15		—	105	210			
5		—	65	130			
10		—	35	70			
15		—	25	50			
Carry Output		5	—	100	200	ns	
		10	—	55	110		
		15	—	40	80		
Minimum Preset Enable Pulse Width, t_W							
Minimum Preset Enable Removal Time, t_{rem}^*							
Carry Input							
Propagation Delay Time: t_{PHL}, t_{PLH} Carry Output	Any Input	5	—	170	340	ns	
		10	—	70	140		
		15	—	50	100		
Min. HOLD Time t_H^{***} Carry In		5	—	25	50	ns	
		10	—	15	30		
		15	—	12	25		
Min Set-Up Time t_S^{***} Carry In		5	—	100	200	ns	
		10	—	35	70		
		15	—	30	60		

* From Up/Down, Binary/Decode, Carry In, or Preset Enable Control Inputs to Clock Edge.

** If more than one unit is cascaded in the parallel clocked application, t_{rCL} should be made less than or equal to the sum of the fixed propagation delay at 15 pF and the transition time of the carry output driving stage for the estimated capacitive load. This measurement was made with a decoupling capacitor ($>1\text{ }\mu\text{F}$) between V_{DD} and V_{SS} .

***From Carry In to Clock Edge

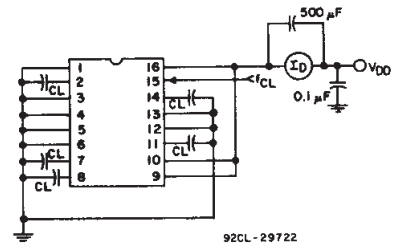


Fig. 13 — Power dissipation test circuit.

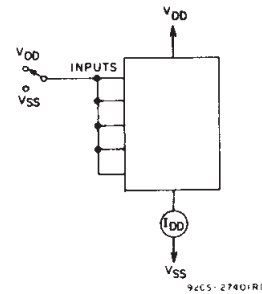


Fig. 14 — Quiescent device current test circuit.

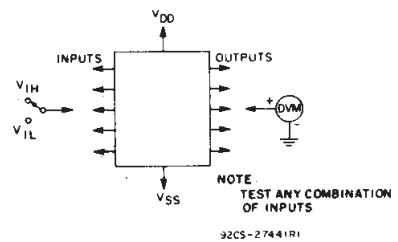


Fig. 15 — Input voltage test circuit.

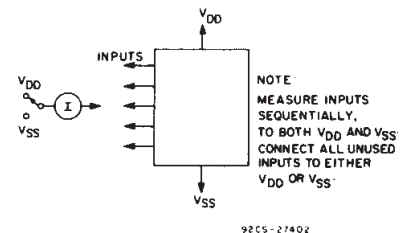
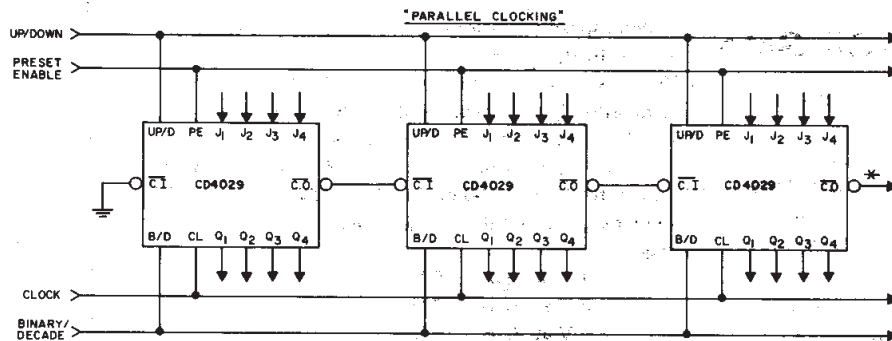
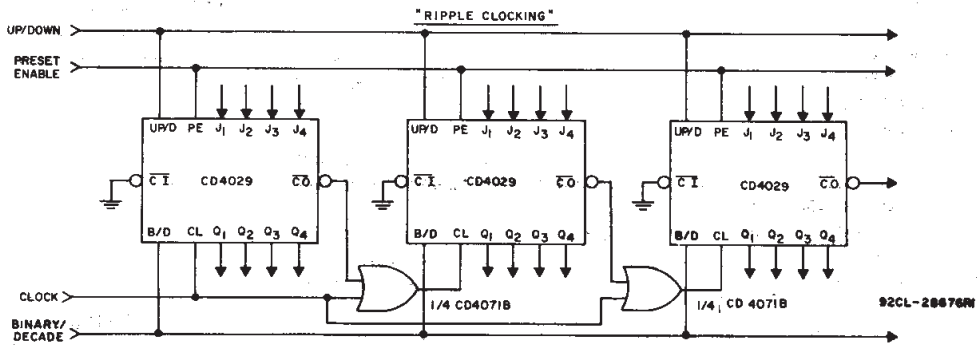


Fig. 16 — Input current test circuit.

CD4029B Types



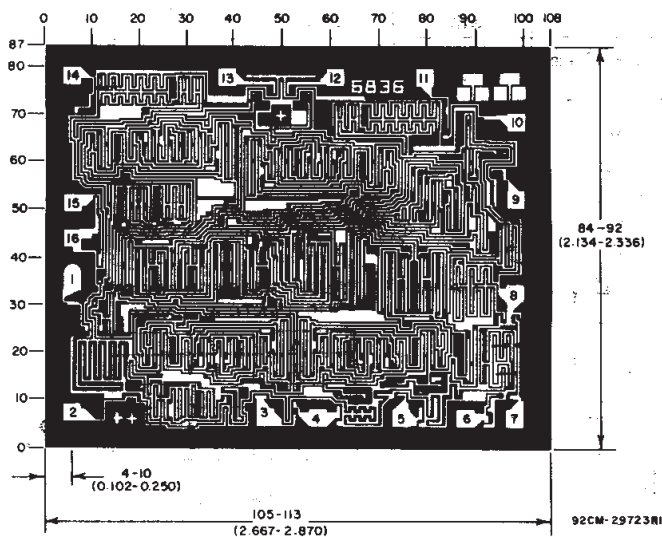
- * CARRY OUT lines at the 2nd, 3rd, etc., stages may have a negative-going glitch pulse resulting from differential delays of different CD4029B IC's. These negative-going glitches do not affect proper CD4029B operation. However, if the CARRY OUT signals are used to trigger other edge-sensitive logic devices, such as FF's or counters, the CARRY OUT signals should be gated with the clock signal using a 2-input OR gate such as CD4071B.



Ripple Clocking Mode:

The Up/Down control can be changed at any count. The only restriction on changing the Up/Down control is that the clock input to the first counting stage must be high. For cascading counters operating in a fixed up-count or down-count mode, the OR gates are not required between stages, and $\overline{CO}$ is connected directly to the CL input of the next stage with $\overline{CI}$ grounded.

Fig. 17 — Cascading counter packages.



Chip dimensions and pad layout for CD4029B

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10^{-3} inch).

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
8101602EA	ACTIVE	CDIP	J	16	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	8101602EA CD4029BF3A	Samples
CD4029BE	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	NIPDAU	N / A for Pkg Type	-55 to 125	CD4029BE	Samples
CD4029BF	ACTIVE	CDIP	J	16	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	CD4029BF	Samples
CD4029BF3A	ACTIVE	CDIP	J	16	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	8101602EA CD4029BF3A	Samples
CD4029BM	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CD4029BM	Samples
CD4029BM96	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CD4029BM	Samples
CD4029BNSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CD4029B	Samples
CD4029BPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-55 to 125	CM029B	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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OTHER QUALIFIED VERSIONS OF CD4029B, CD4029B-MIL :

- Catalog: [CD4029B](#)
- Military: [CD4029B-MIL](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

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

TAPE AND REEL INFORMATION

*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
CD4029BM96	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
CD4029BNSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
CD4029BPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD4029BM96	SOIC	D	16	2500	333.2	345.9	28.6
CD4029BNSR	SO	NS	16	2000	367.0	367.0	38.0
CD4029BPWR	TSSOP	PW	16	2000	367.0	367.0	35.0

N (R-PDIP-T**)

16 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE



PINS **	14	16	18	20
DIM				
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-001 VARIATION	AA	BB	AC	AD

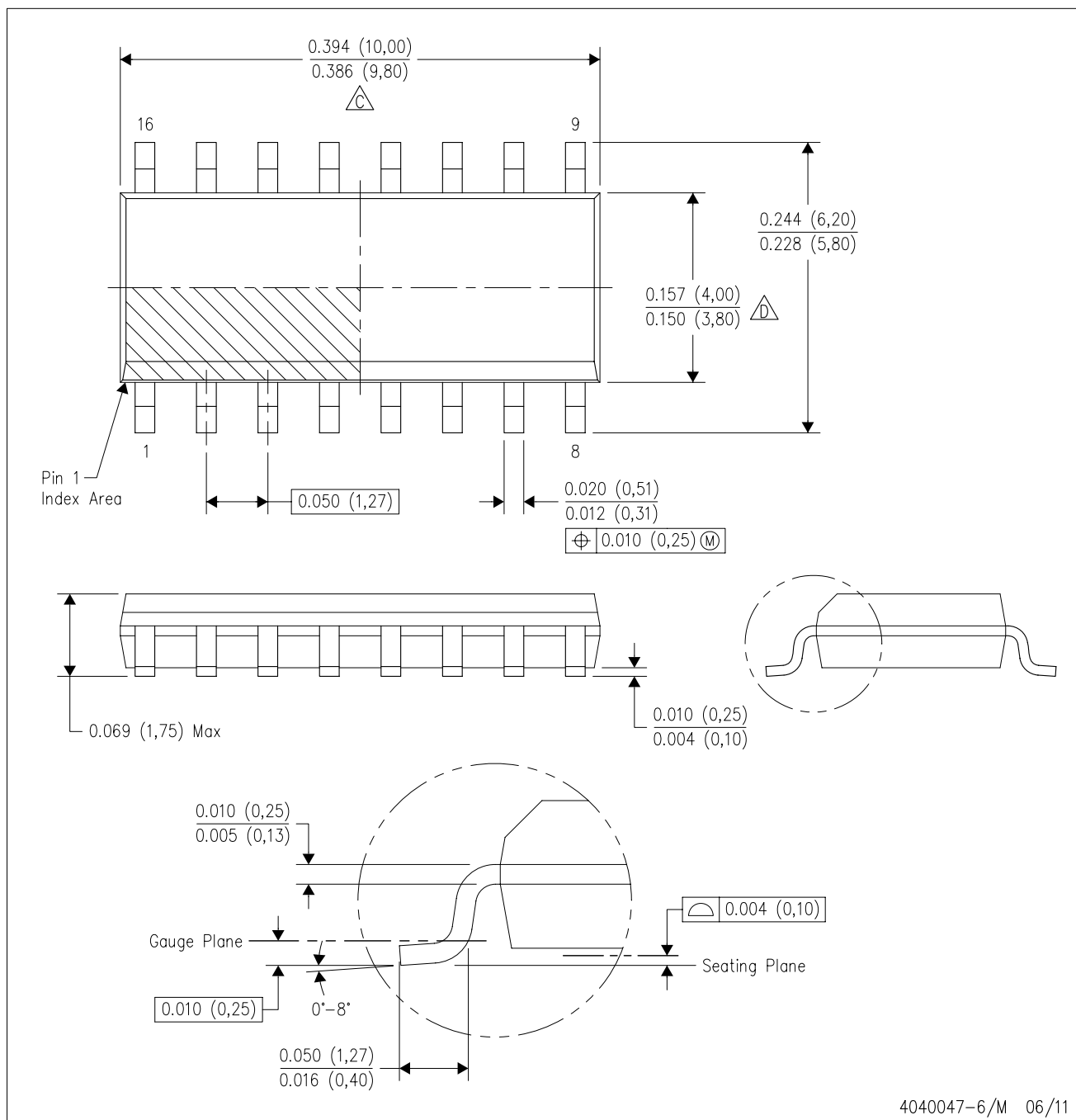


4040049/E 12/2002

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - The 20 pin end lead shoulder width is a vendor option, either half or full width.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4040047-6/M 06/11

NOTES:

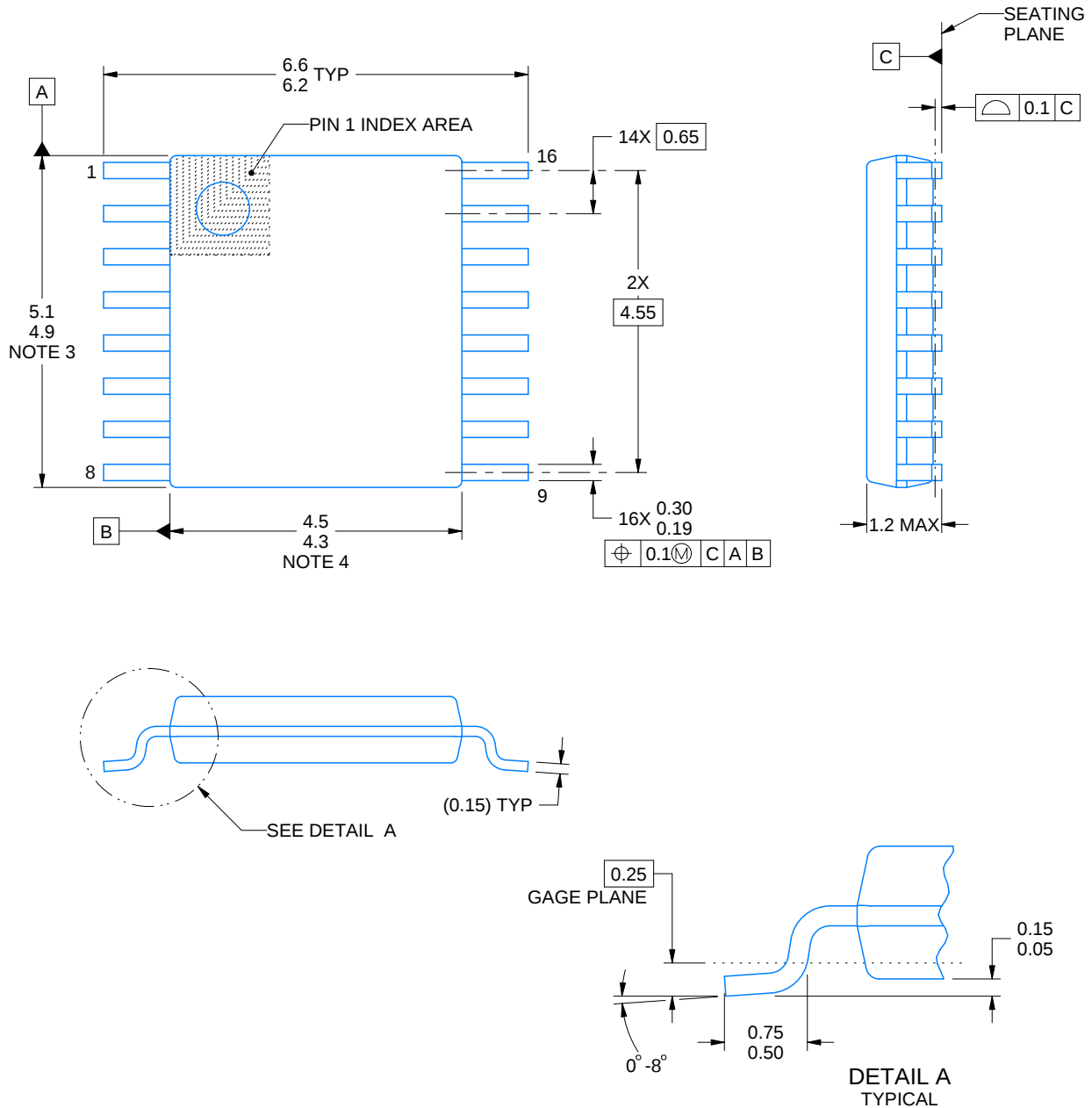
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AC.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



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



4220204/A 02/2017

NOTES:

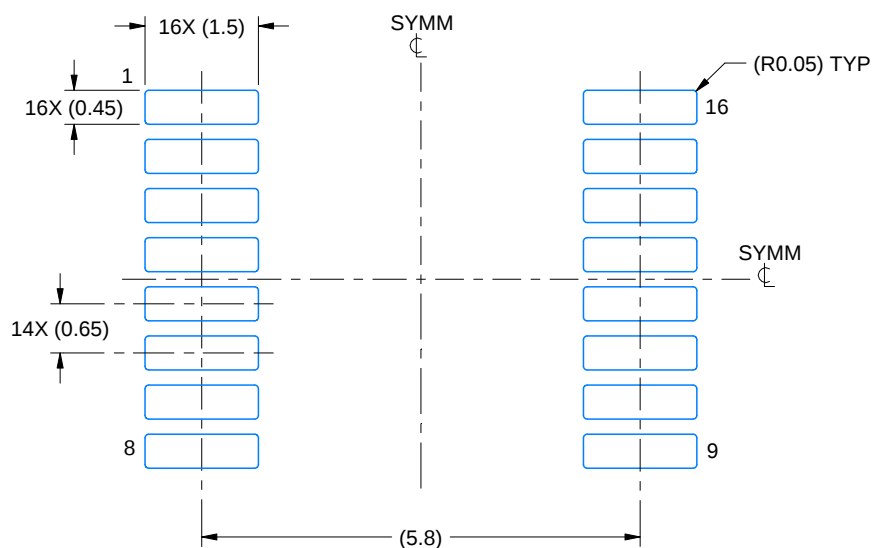
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

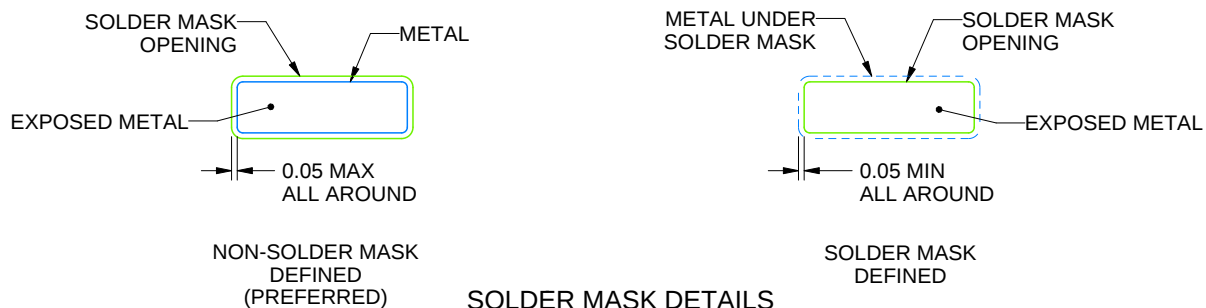
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4220204/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220204/A 02/2017

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



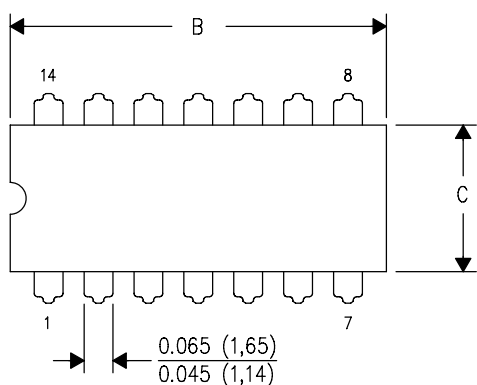
DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

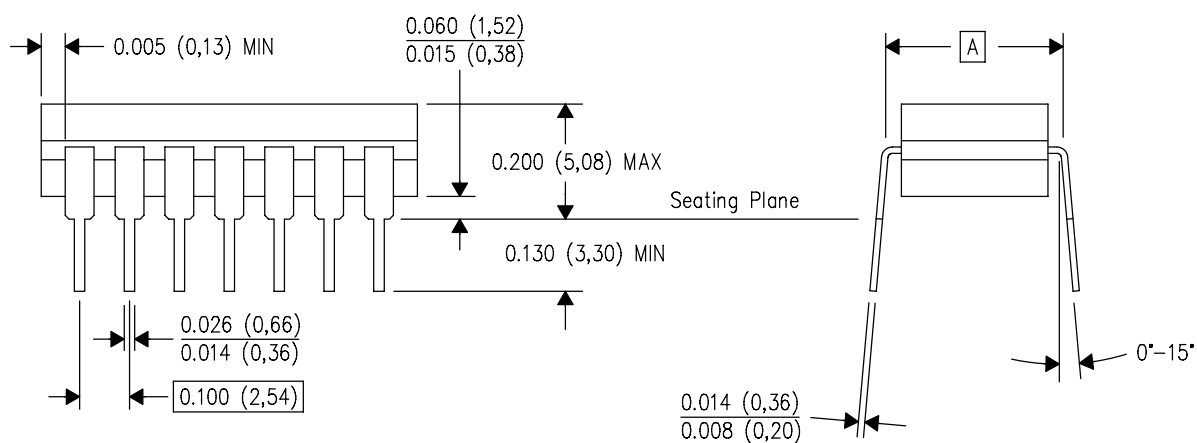
- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. This package is hermetically sealed with a ceramic lid using glass frit.
- D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
- E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

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