

CD4029B Types

CMOS Presettable Up/Down Counter

Binary or BCD-Decade

High-Voltage Types (20-Volt Rating)

The RCA-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.

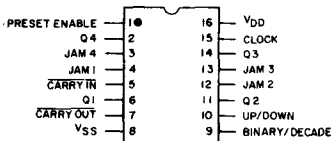
A high **PRESET ENABLE** signal allows information on the **JAM INPUTS** to preset the counter to any state asynchronously with the clock. A low on each **JAM** line, when the **PRESET-ENABLE** signal is high, resets the counter to its zero count. The counter is advanced one count at the positive transition 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 ceramic dual-in-line plastic packages (E suffix), 16-lead ceramic flat packages (K suffix), and in chip form (H suffix).

CD4029B Terminal Diagram



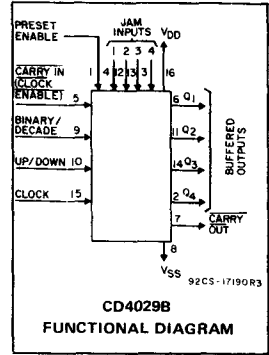
92CS-24472R1

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 μ 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. 13A, "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 $T_A = 25^\circ\text{C}$, 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	60	—	
	10	20	—	
	15	12	—	
U/D or B/D	5	340	—	ns
	10	140	—	
	15	100	—	
Clock Pulse Width, t_W	5	180	—	
	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	—	—	μ s
	10	—	15	
	15	—	—	

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MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, (V_{DD})	(Voltages referenced to V_{SS} Terminal)	-0.5 to +20 V
INPUT VOLTAGE RANGE, ALL INPUTS		-0.5 to $V_{DD} + 0.5$ V
DC INPUT CURRENT, ANY ONE INPUT		± 10 mA
POWER DISSIPATION PER PACKAGE (P_D):		
For $T_A = -40$ to $+60^\circ\text{C}$ (PACKAGE TYPE E)		500 mW
For $T_A = +60$ to $+85^\circ\text{C}$ (PACKAGE TYPE E)		Derate Linearly at 12 mW/ $^\circ\text{C}$ to 200 mW
For $T_A = -55$ to $+100^\circ\text{C}$ (PACKAGE TYPES D, F, K)		500 mW
For $T_A = +100$ to $+125^\circ\text{C}$ (PACKAGE TYPES D, F, K)		Derate Linearly at 12 mW/ $^\circ\text{C}$ to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR		
For $T_A = \text{FULL PACKAGE-TEMPERATURE RANGE (All Package Types)}$		100 mW
OPERATING-TEMPERATURE RANGE (T_A):		
PACKAGE TYPES D, F, K, H		-55 to $+125^\circ\text{C}$
PACKAGE TYPE E		-40 to $+85^\circ\text{C}$
STORAGE TEMPERATURE RANGE (T_{stg})		-65 to $+150^\circ\text{C}$
LEAD TEMPERATURE (DURING SOLDERING):		$+265^\circ\text{C}$
At distance 1/16 \pm 1/32 inch (1.59 \pm 0.79 mm) from case for 10 s max.		

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES ($^\circ\text{C}$)							UNITS
				Values at -55, +25, +125 Apply to D, F, K, H Packages Values at -40, +25, +85 Apply to E Package							
				-55	-40	+85	+125	+25			
V_O (V)	V_{IN} (V)	V_{DD} (V)					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	-	$\pm 10^{-5}$	± 0.1	μA

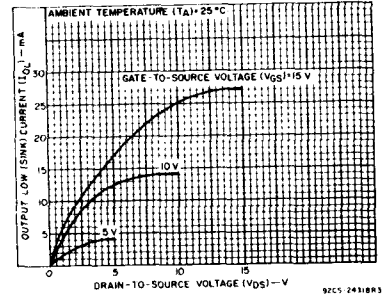


Fig. 1 - Typical output low (sink) current characteristics.

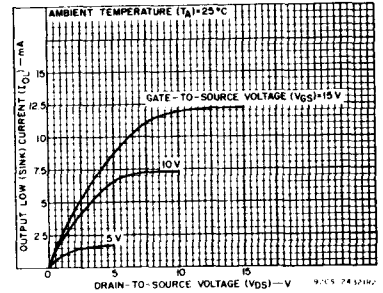


Fig. 2 - Minimum output low (sink) current characteristics.

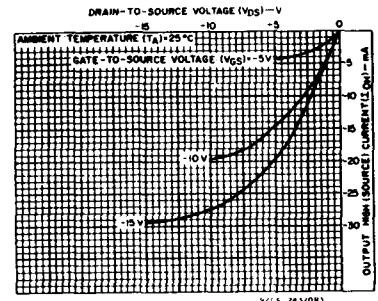


Fig. 3 - Typical output high (source) current characteristics.

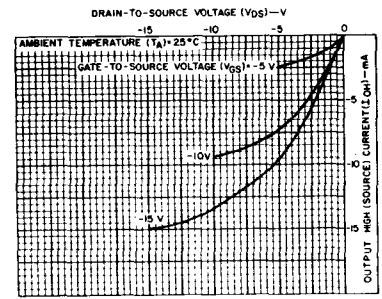


Fig. 4 - Minimum output high (source) current characteristics.

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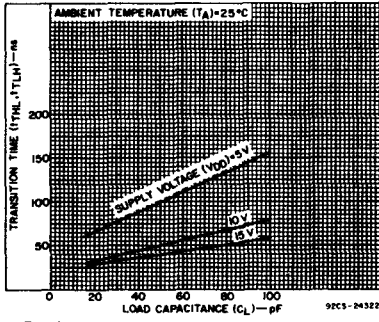


Fig. 5 - Typical transition time as a function of load capacitance.

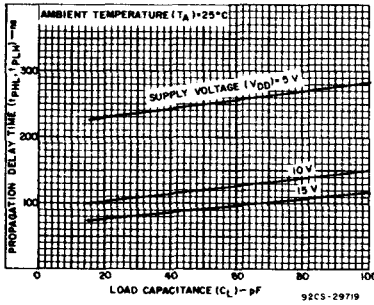


Fig. 6 - Typical propagation delay times as a function of load capacitance (Q output).

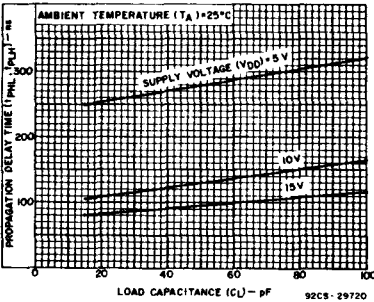


Fig. 7 - Typical propagation delay time as a function of load capacitance (carry output).

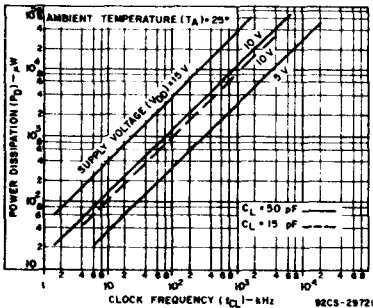
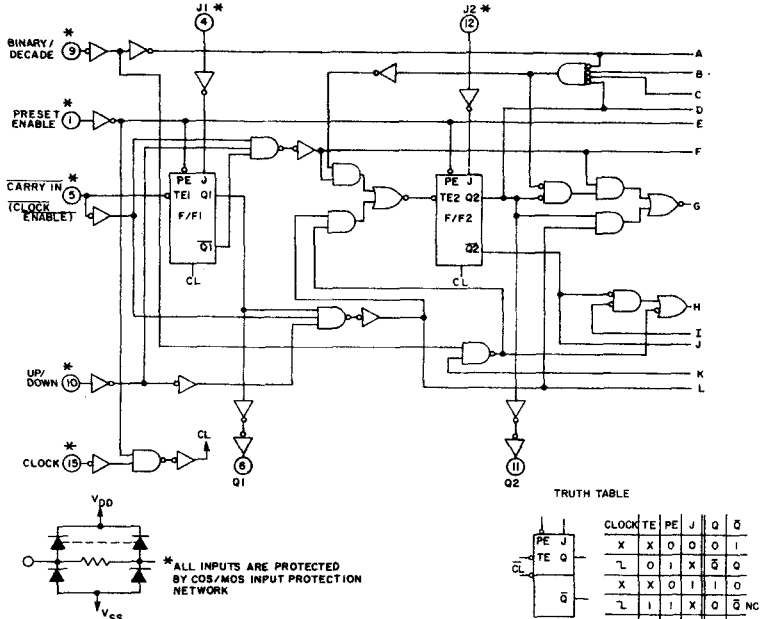


Fig. 8 - Typical power dissipation as a function of frequency.



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Fig. 9 - Logic diagram.

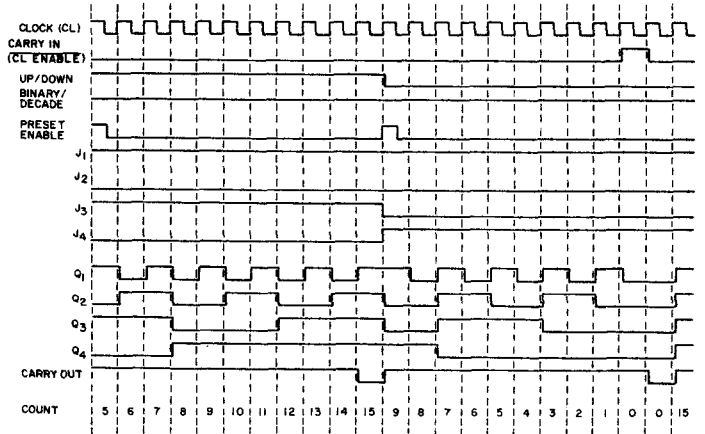
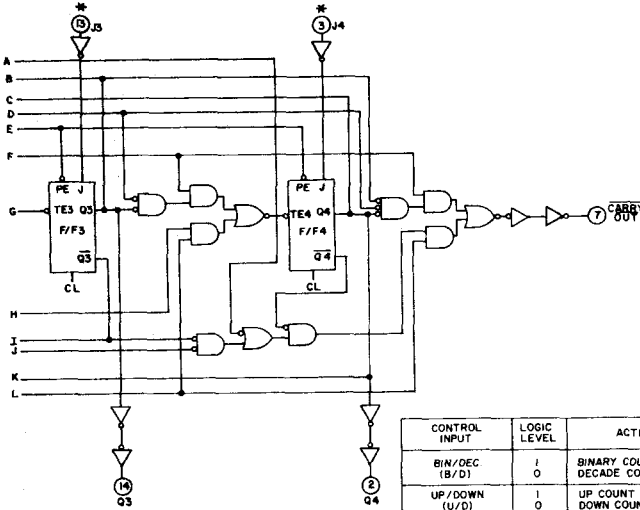


Fig. 10 - Timing diagram-binary mode.

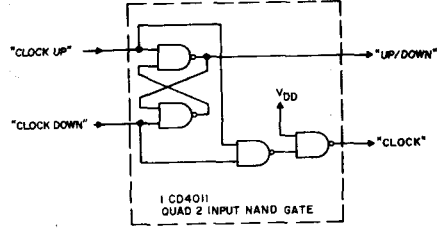
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CONTROL INPUT	LOGIC LEVEL	ACTION
BIN/DEC (B/D)	0	BINARY COUNT DECADE COUNT
UP/DOWN (U/D)	1	UP COUNT DOWN COUNT
PRESET ENABLE (PE)	1	JAM IN NO JAM
CARRY IN (CT) (CLOCK ENABLE)	1	NO COUNTER ADVANCE AT POS. CLOCK TRANSITION
	0	ADVANCE COUNTER AT POS.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

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Fig. 9 - Logic diagram (cont'd).

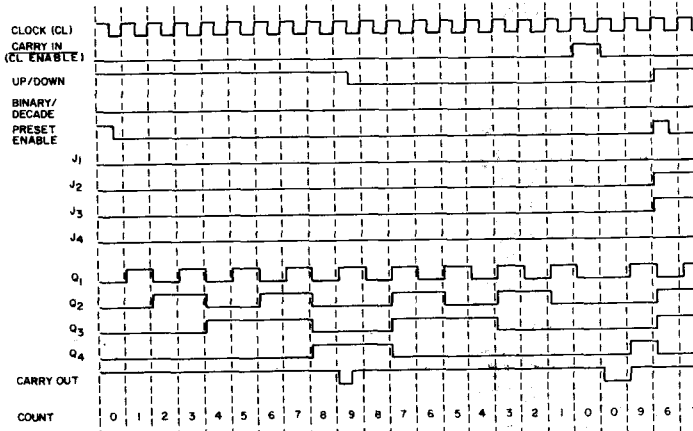


92CS-17195R2

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.



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Fig. 12 - Timing diagram-decade mode.

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

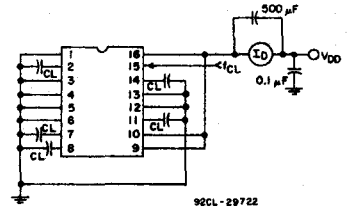


Fig. 13 - Power dissipation test circuit.

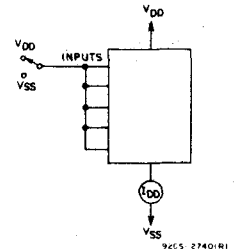


Fig. 14 - Quiescent-device current test circuit.

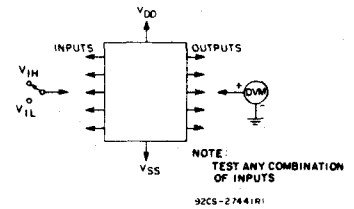


Fig. 15 - Input voltage test circuit.

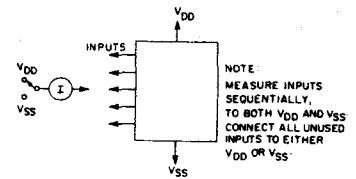
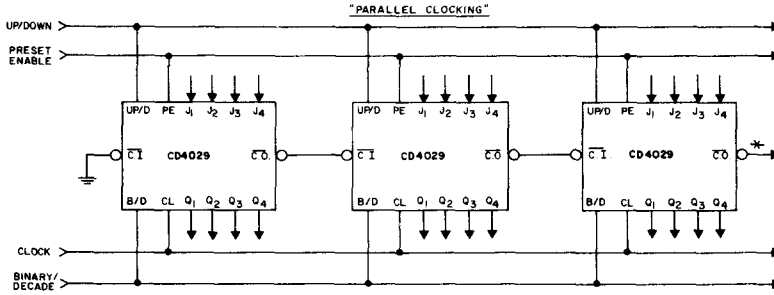
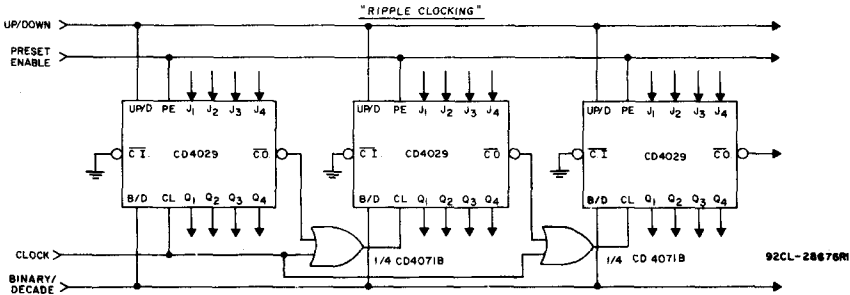


Fig. 16 - Input current test circuit.

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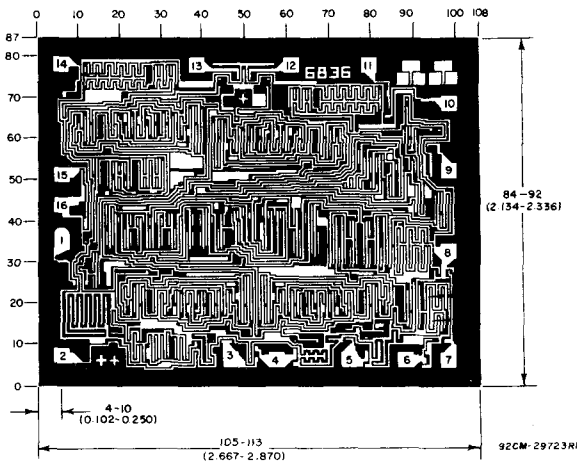
* CARRY OUT lines at the 2nd, 3rd, etc., stages may have a negative-going glitch resulting from differential delays of different CD4029B IC's. These negative-going glitches do not affect proper CD4029B operation. However, if the CARRY OUT signals are used to trigger other edge-sensitive logic devices, 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 CO is connected directly to the CL input of the next stage with CI grounded.

Fig. 17 - Cascading counter packages.



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).

The photographs and dimensions of each CMOS chip represent a chip when it is part of the wafer. When the wafer is separated into individual chips, the angle of cleavage may vary with respect to the chip face for different chips. The actual dimensions of the isolated chip, therefore, may differ slightly from the nominal dimensions shown. The user should consider a tolerance of -3 mils to $+16$ mils applicable to the nominal dimensions shown.