



# CD4059A Types

## MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, ( $V_{DD}$ ) Voltages referenced to $V_{SS}$ Terminal)	-0.5V to +15V
INPUT VOLTAGE RANGE, ALL INPUTS	-0.5V to $V_{DD}$ +0.5V
POWER DISSIPATION PER PACKAGE ( $P_D$ ):	
For $T_A = -55^\circ\text{C}$ to $+100^\circ\text{C}$	500mW
For $T_A = +100^\circ\text{C}$ to $+125^\circ\text{C}$	Derate Linearly to 100mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
FOR $T_A =$ FULL PACKAGE-TEMPERATURE RANGE (All Package Types)	100mW
OPERATING-TEMPERATURE RANGE ( $T_A$ )	$-55^\circ\text{C}$ to $+125^\circ\text{C}$
STORAGE TEMPERATURE RANGE ( $T_{stg}$ )	$-85^\circ\text{C}$ to $+150^\circ\text{C}$
LEAD TEMPERATURE (DURING SOLDERING):	
At distance $1/16 \pm 1/32$ inch ( $1.59 \pm 0.79\text{mm}$ ) from case for 10s max	

## OPERATING CONDITIONS AT $T_A = 25^\circ\text{C}$ (Unless otherwise specified)

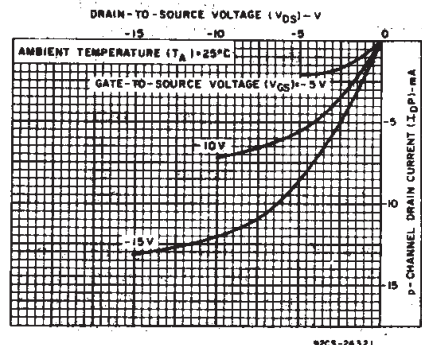
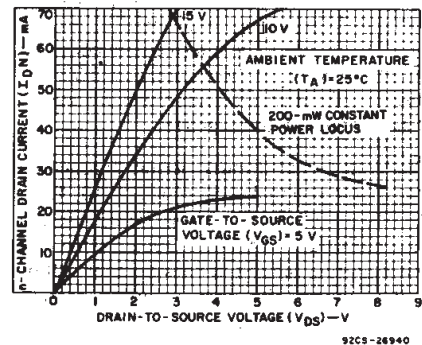
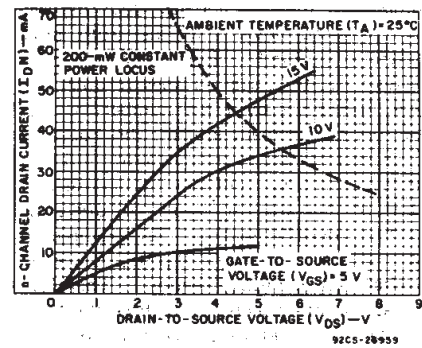
For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges.

Characteristic	$V_{DD}$	Min.	Max.	Units
Supply Voltage Range (over full temp. range)	-	3	12	V
Clock Pulse Width	5	200	-	ns
Clock Input Frequency	10	-	1.5	MHz
Clock Input Rise and Fall Time	5	-	15	$\mu\text{s}$

## STATIC ELECTRICAL CHARACTERISTICS

Characteristic	Conditions			Limits							Units
	$V_O$ (V)	$V_{IN}$ (V)	$V_{DD}$ (V)	$-55^\circ$	$-40^\circ$	$+85^\circ$	$+125^\circ$	$+25^\circ$			
								Min.	Typ.	Max.	
Quiescent Device Current, $I_L$ Max.			5	10	10	700	300	-	0.02	10	$\mu\text{A}$
			10	20	20	200	400	-	0.02	20	
			15	-	-	-	-	-	-	500	
Output Voltage:											V
	Low Level, $V_{OL}$ Max.	0.5	5		0.05			-	0	0.05	
	High Level, $V_{OH}$ Min.	0.5	5		4.95			4.95	5	-	
		0.10	10		9.95			9.95	10	-	
Noise Immunity:											V
	Inputs Low, $V_{NL}$ Min.		5		1.5			1.5	2.25	-	
	Inputs High, $V_{NH}$ Min.		10		3			3	4.5	-	
			5		1.5			1	2.25	-	
Noise Margin:											V
	Inputs Low, $V_{NML}$ Min.	4.5	5				1				
	Inputs High, $V_{NMH}$ Min.	9	10				1				
		0.5	5				1				
Output Drive Current:											mA
	N-Channel (Sink) $I_{DN}$ Min.	0.4	5	2.5	2.3	1.6	1.4	2	4	-	
		0.5	10	5	4.7	3.3	2.8	4	9	-	
	P-Channel (Source) $I_{DP}$ Min.	2.5	5	-2	-1.8	-1.3	-1.15	-1.6	-3.2	-	
	4.6	5	-0.5	-0.45	-0.36	-0.3	-0.4	-0.8	-		
	9.5	10	-1.1	-1	-0.75	-0.65	-0.9	-1.8	-		
Input Leakage Current: * $I_{IL}, I_{IH}$ Max.			15			$\pm 1$			$\pm 10^{-5}$	$\pm 1$	$\mu\text{A}$

\* Any Input



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

CHARACTERISTIC	CONDITIONS $V_{DD}$ (V)	LIMITS ALL PACKAGES			UNITS
		Min.	Typ.	Max.	
Propagation-Delay Time: $t_{PHL}, t_{PLH}$	5	—	180	360	ns
	10	—	90	180	
Transition Time:	$t_{THL}$	5	—	35	ns
		10	—	20	
	$t_{TLH}$	5	—	100	ns
		10	—	50	
Maximum Clock Input Frequency, $f_{CL}$	5	1.5	3	MHz	
	10	3	6		
Average Input Capacitance, $C_i$ (any input)	—	—	5	pF	

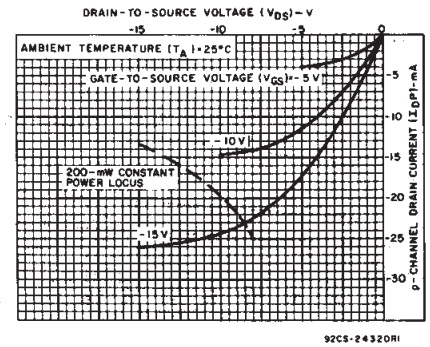


Fig. 6 - Typical output p-channel drain characteristics.

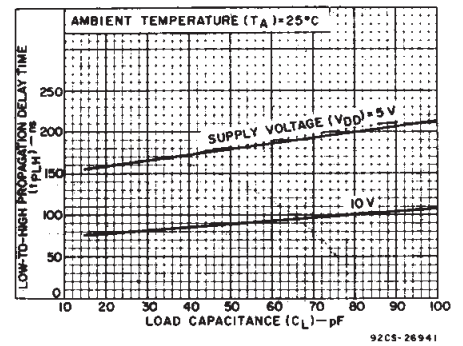


Fig. 7 - Typical low-to-high propagation delay time vs. load capacitance.

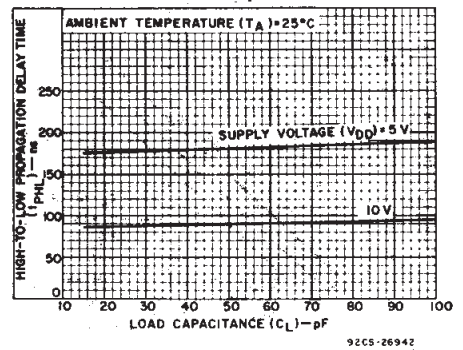


Fig. 8 - Typical high-to-low propagation delay time vs. load capacitance.

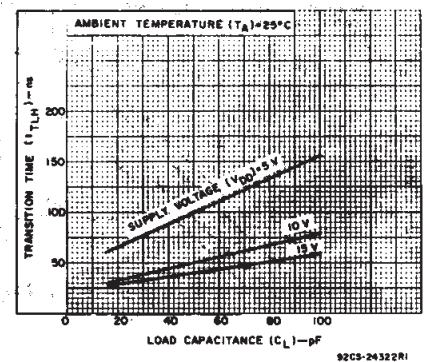
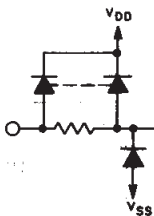
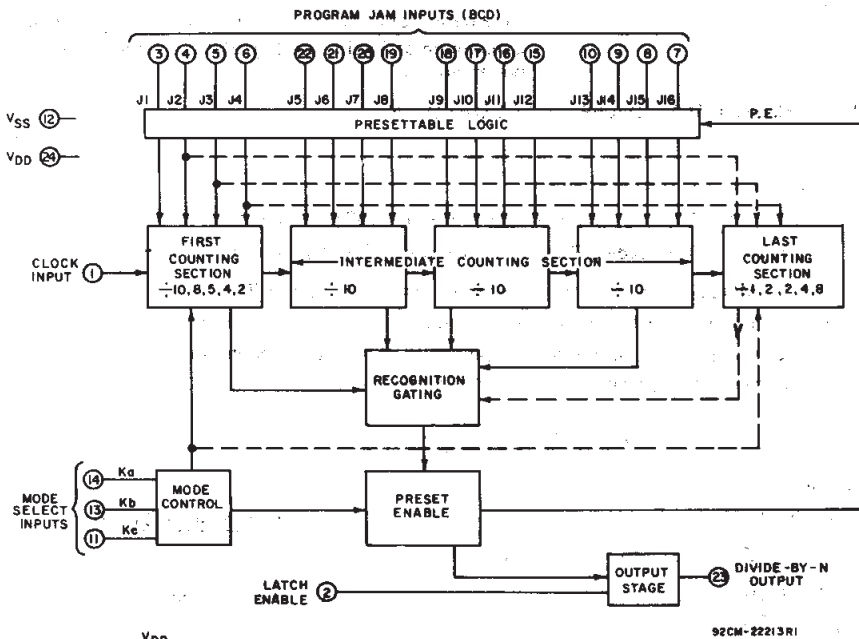


Fig. 9 - Typical low-to-high transition time vs. load capacitance.



ALL INPUTS (TERMS. 1-11, 13-22) PROTECTED BY CMOS PROTECTION NETWORK

Fig. 5 - Functional block diagram.

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PROGRAM JAM INPUTS																			
6				1				7				4				5			
J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11	J12	J13	J14	J15	J16				
0	1	1	1	1	1	1	0	0	0	1	0	1	0	1	0				

To verify:

$$N = 8 (1000 \times 1 + 100 \times 5 + 10 \times 4 + 1 \times 7) + 6$$

$$N = 12382$$

MODE SELECT = 10

C) N = 8479, Mode = 10

$$\begin{array}{r} 0847 + 9 \\ 10 \overline{) 8479} \end{array}$$

Ka Kb Kc  
1 1 0

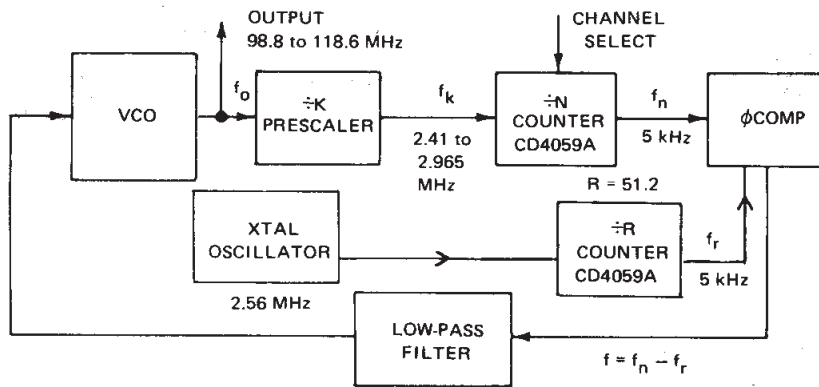
PROGRAM JAM INPUTS															
9				7				4				8			
J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11	J12	J13	J14	J15	J16
1	0	0	1	1	1	1	0	0	0	1	0	0	0	0	1

To Verify:

$$N = 10 (1000 \times 0 + 100 \times 8 + 10 \times 4 + 1 \times 7) + 9$$

$$N = 8479$$

## DIGITAL PHASE-LOCKED LOOP (PLL) FOR FM BAND SYNTHESIZER



### 1) Calculating Min & Max "N" Values :

Output Freq. Range ( $f_o$ ) = 98.8 to 118.6 MHz

Channel Spacing Freq. ( $f_c$ ) = 200 kHz

Division Factor ( $k$ ) = 40

$$\text{Reference Freq. } (f_r) = \frac{f_c}{k} = \frac{200}{40} \text{ kHz} = 5 \text{ kHz}$$

$$f_k = \frac{f_o}{40} : f_{k\text{Max.}} = \frac{118.6 \text{ MHz}}{40} = 2.965 \text{ MHz}; f_{k\text{Min.}} = \frac{98.8 \text{ MHz}}{40} = 2.47 \text{ MHz}$$

$$\therefore N = \frac{f_o}{f_c}$$

$$N_{\text{Max}} = \frac{118.6 \text{ MHz}}{200 \text{ kHz}} = 593$$

$$N_{\text{Min}} = \frac{98.8 \text{ MHz}}{200 \text{ kHz}} = 494$$

$$R = \frac{2.56 \text{ MHz}}{5 \text{ kHz}} = 512$$

## "CASCADING" VIA OTHER COUNTERS

Fig. 14 shows a BCD-switch compatible arrangement suitable for  $\div 8$  and  $\div 5$  modes, which can be adapted, with slight changes, to the other divide-by-modes. In order to be able to preset to any number from three to about 256,000, while preserving the BCD-switch compatible character of the jam inputs, a rather complex cascading scheme is required. Such a cascading scheme is necessary because the CD4059A can never be preset to a count less than 3 and logic is needed to detect the condition that one of the numbers to be preset in the CD4059A is rather small. In order to simplify the detection logic, only that condition is detected where the jam inputs to terminals 6, 7, and 9 would be low during one count. If such a condition is detected, and if at least 1 is expected to be jammed into the MSB counter (with a place value of 2000 times the divide-by-mode) and jams the same 2000 into the CD4059A by forcing terminals 6, 7, and 9 high.

The clock of the CD4013A may be driven directly from the output of the CD4059A, as shown by dashed option (1), or by the inverted output of the CD4059A, option (2). If option (2) is used the CD4029A cannot count cycles shorter than 3. If option (1) is used propagation delay problems may occur at high counting speeds.

The general circuit in Fig.14 can be simplified considerably if the range of the cascaded counters does not have to start at a very low value. Fig.15 shows an arrangement in the  $\div 4$  mode, where the counting range extends in a BCD-switch compatible manner from 88,003 to 103,999. The arrangement shown in Fig.15 is easy to follow; once during each cycle, the less significant digits are jammed in (14,712 in this case) and then 11,000 ( $4 \times 2750$ ) is jammed in eight times in succession, by forcing jam inputs high or low, as required.

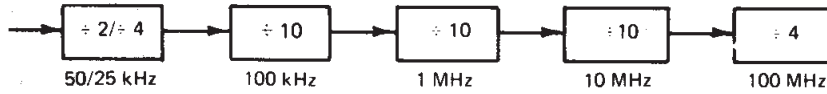
Numbers larger than the extended counter range can also be produced by cascading the CD4059A with some other counting device. Fig.16 shows such an arrangement where only one fixed divide-by number is desired which is close to three times the extended counter range as shown in the last column of Table I. The dual flip-flop wired to produce a  $\div 3$  count, can be replaced by other counters such as the CD4029, CD4510, CD4516, CD4017, or the CD4022. In Fig.16 the  $\div N$  subsystem is preset once to a number smaller than the desired divide-by number. This smaller number represents the less significant digits of the divide-by number. The subsystem is then preset one or more times to a round number (e.g. 1000, 2000) and multiplied by the number of the divide-by mode ( $\div 2$  in the example of Fig.16). It is important that the second counting device has an output that is high or low, as the case may be, during only one of its counting states.

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### 2) ÷ N Counter Configuration for UHF – 220 to 400 MHz

Channel Spacing: 50 kHz or 25 kHz

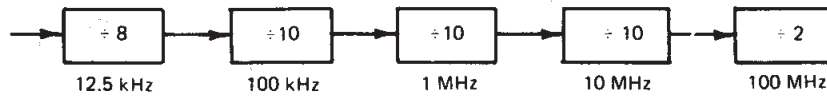


$$N_{Max} = \frac{400 \text{ MHz}}{25 \text{ kHz}} = 16,000 \quad N_{Max} = \frac{400 \text{ MHz}}{50 \text{ kHz}} = 8,000$$

$$N_{Min} = \frac{220 \text{ MHz}}{25 \text{ kHz}} = 8,800 \quad N_{Min} = \frac{220 \text{ MHz}}{50 \text{ kHz}} = 4,400$$

### 3) ÷ N Counter Configuration to VHF – 116 MHz

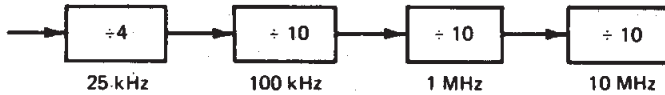
Channel Spacing = 12.5 kHz



$$N_{Max} = \frac{160 \text{ MHz}}{12.5 \text{ kHz}} = 12,800 \quad N_{Min} = \frac{116 \text{ MHz}}{12.5 \text{ kHz}} = 9,300$$

### 4) ÷ N Counter Configuration for VHF – 30 to 80 MHz

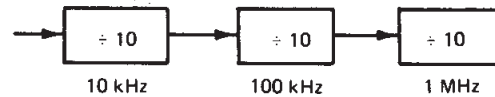
Channel Spacing: 25 kHz



$$N_{Max} = \frac{80 \text{ MHz}}{25 \text{ kHz}} = 3,200 \quad N_{Min} = \frac{30 \text{ MHz}}{25 \text{ kHz}} = 1,200$$

### 5) ÷ N Counter Configuration for AM – 995 to 2055 kHz

Channel Spacing = 10 kHz



$$N_{Max} = \frac{2055 \text{ kHz}}{10 \text{ kHz}} = 205 \quad N_{Min} = \frac{995 \text{ kHz}}{10 \text{ kHz}} = 99$$

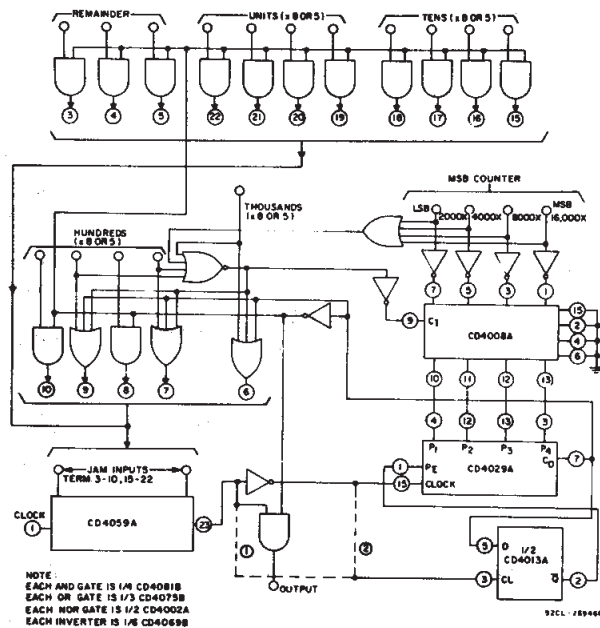


Fig.14 – BCD switch-compatible ÷N system of the most general kind.

# CD4059A Types

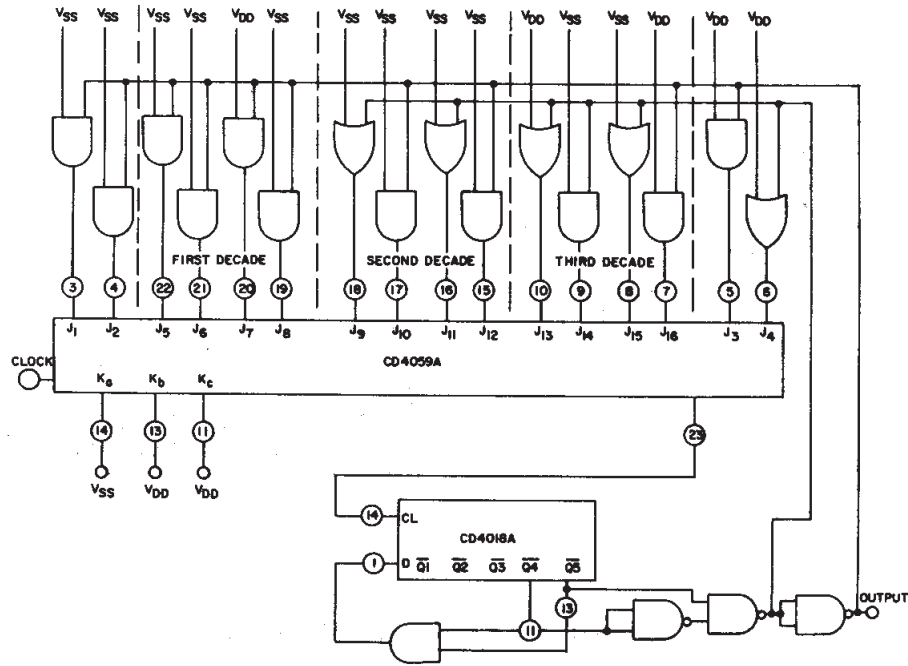


Fig. 15 - Dividing by any number from 88,003 to 103,999.

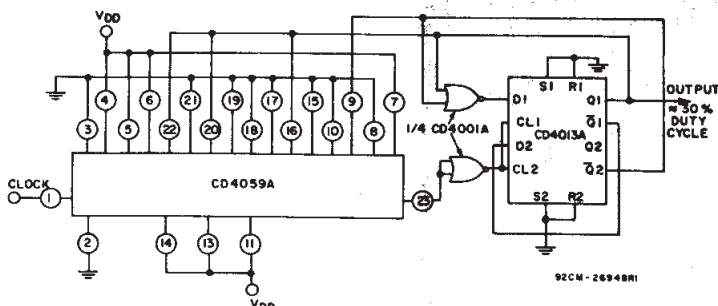


Fig. 16 - Division by 47,690 in ÷2 mode.

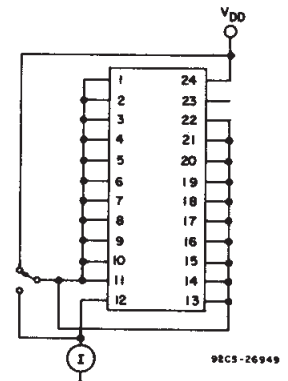


Fig. 17 - Quiescent device current test circuit.

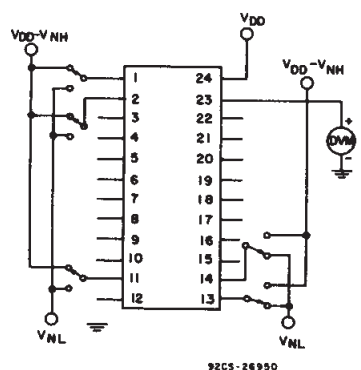


Fig. 18 - Noise immunity test circuit.

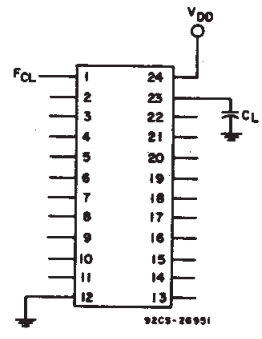


Fig. 19 - Power dissipation test circuit (all ÷ modes).

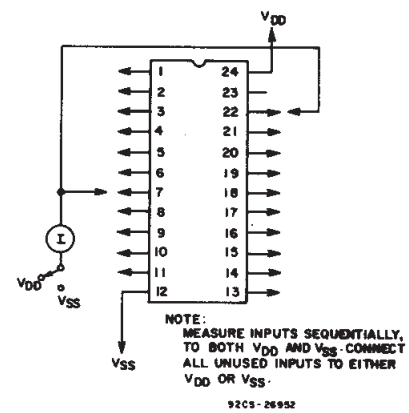
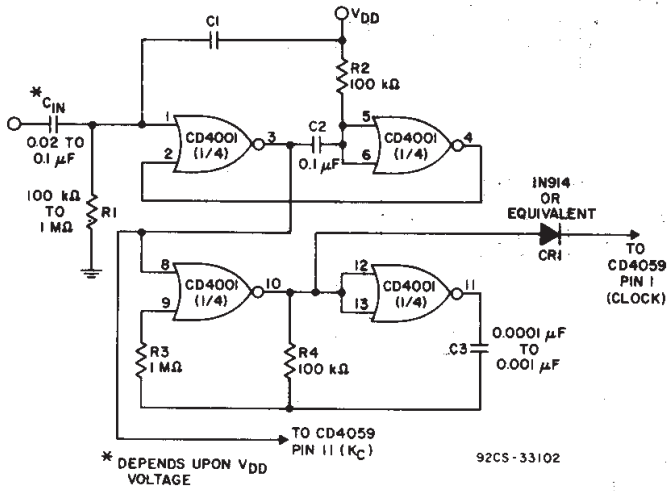


Fig. 20 - Input leakage current test circuit.

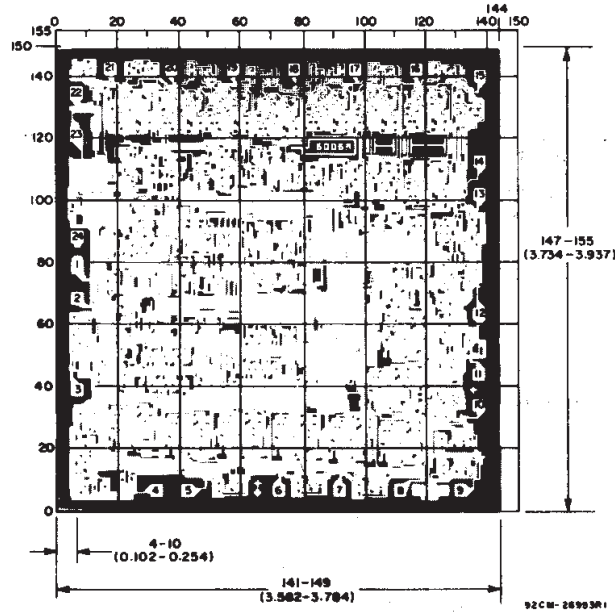
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For changing from any mode other than mode 5 (with power on), apply positive pulse to C<sub>in</sub>. This circuit automatically selects master preset mode (K<sub>b</sub> = 0, K<sub>c</sub> = 0) before going into the select conditions for mode 5 (K<sub>a</sub> = 1, K<sub>b</sub> = 0, K<sub>c</sub> = 1). The selection of C<sub>1</sub> and C<sub>2</sub> is critical! C<sub>1</sub> is determined by the V<sub>DD</sub> voltage--the lower V<sub>DD</sub>'s need larger C<sub>1</sub>'s. C<sub>2</sub> must be 0.1 μF or larger.

Fig.21 - CD4059A mode 5 power on master preset circuit.



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10<sup>-3</sup> inch).

Dimensions and pad layout for CD4059AH.



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