



T-75-11-21
CD22101
CD22102

**CMOS 4 x 4 x 2 Crosspoint Switch
 With Control Memory**

August 1991

Features

- Low ON Resistance 75V Typ. at $V_{DD} = 12V$
- "Built-In" Latched Inputs
- Large Analog Signal Capability $\pm V_{DD}/2$
- Switch Bandwidth 10MHz
- Matched Switch Characteristics $\Delta R_{ON} = 8\Omega$ Typ. at $V_{DD} = 12V$
- High Linearity - 0.25% Distortion (Typ.) at $f = 1kHz$, $V_{IN} = 5Vp-p$, $V_{DD} - V_{SS} = 10V$, and $R_1 = 1k\Omega$
- Standard CMOS Noise Immunity

Applications

- Telephone Systems
- PBX
- Studio Audio Switching
- Multisystem Bus Interconnect

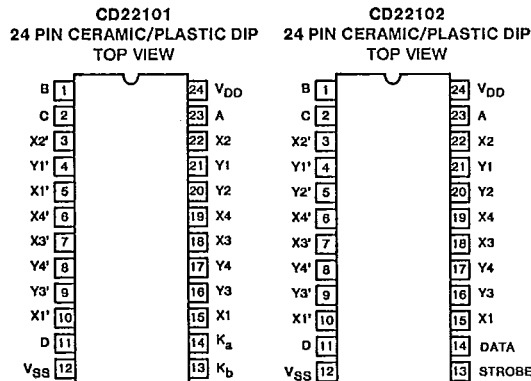
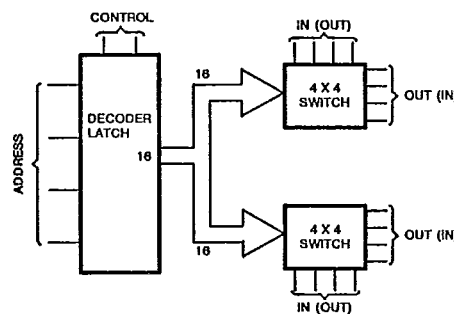
Description

CD22101 and CD22102 crosspoint switches consist of 4 x 4 x 2 arrays of crosspoint (transmission gates) 4-line to 16-line decoders and 16 latch circuits. Any one of the sixteen crosspoint pairs can be selected by applying the appropriate four-line address, and any number of crosspoints can be ON simultaneously. Corresponding crosspoints in each array are turned on and off simultaneously, also.

In the CD22101, the selected crosspoint pair can be turned on or off by applying a logical ONE or ZERO, respectively, to the data input, and applying a ONE to the strobe input. When the device is "powered up", the states of the 16 switches are indeterminate. Therefore, all switches must be turned off by putting the strobe high, data-in low, and then addressing all switches in succession.

The selected pair of crosspoints in the CD22102 is turned on by applying a logical ONE to the K_A (set) input while a logical ZERO is on the K_B input, and turned off by applying a logical ONE to the K_B (reset) input while a logical ZERO is on the K_A input. In this respect, the control latches of the CD22102 are similar to SET/RESET flip-flops. They differ, however, in that the simultaneous application of ONE's to the K_A and K_B inputs turns off (resets) all crosspoints. All crosspoints in both devices must be turned off as V_{DD} is applied.

The CD22101 and CD22102 types are supplied in 24 lead Hermetic dual-in-line ceramic packages (D and F suffixes), 24 lead dual-in-line plastic packages (E suffix).

Pinouts**Functional Diagram**

CAUTION: These devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.
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Specifications CD22101, CD22102

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) 500 mW

For $T_A = +100$ to $+125^\circ\text{C}$ (PACKAGE TYPES D, F) 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, 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):

At distance $1/16 \pm 1/32$ inch (1.59 ± 0.79 mm) from case for 10 s max. $+265^\circ\text{C}$

* Maximum current through transmission gates (switches) = 25 mA.

RECOMMENDED OPERATING CONDITIONS

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

CHARACTERISTIC	LIMITS		UNITS
	Min.	Max.	
Supply-Voltage Range (For $T_A = \text{Full Package-Temperature Range}$)	3	18	V

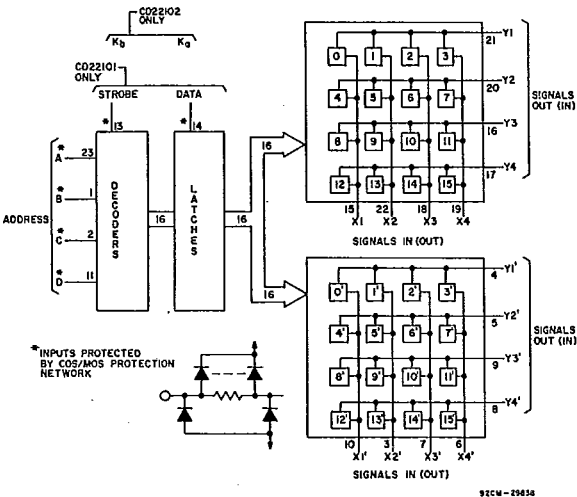


Fig. 1 - Functional block diagram.

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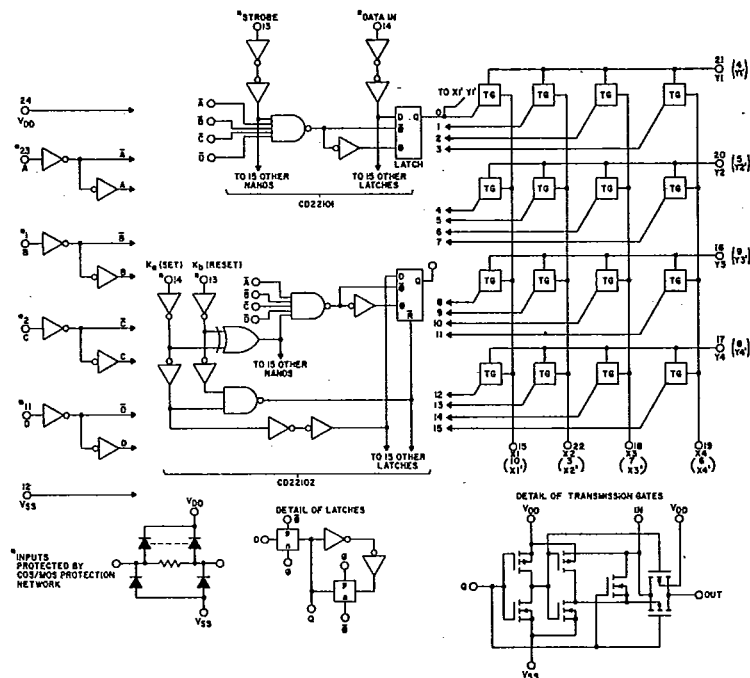


Fig. 2 - Logic diagram.

DECODER TRUTH TABLE

Address	Select	Address	Select
A B C D		A B C D	
0 0 0 0	X1Y1 & X1'Y1'	0 0 0 1	X1Y3 & X1'Y3'
1 0 0 0	X2Y1 & X2'Y1'	1 0 0 1	X2Y3 & X2'Y3'
0 1 0 0	X3Y1 & X3'Y1'	0 1 0 1	X3Y3 & X3'Y3'
1 1 0 0	X4Y1 & X4'Y1'	1 1 0 1	X4Y3 & X4'Y3'
0 0 1 0	X1Y2 & X1'Y2'	0 0 1 1	X1Y4 & X1'Y4'
1 0 1 0	X2Y2 & X2'Y2'	1 0 1 1	X2Y4 & X2'Y4'
0 1 1 0	X3Y2 & X3'Y2'	0 1 1 1	X3Y4 & X3'Y4'
1 1 1 0	X4Y2 & X4'Y2'	1 1 1 1	X4Y4 & X4'Y4'

CONTROL TRUTH TABLE FOR CD22101

Function	Address	Strobe	Data	Select
	A B C D			
Switch On	1 1 1 1	1	1	15 (X4Y4) & 15' (X4'Y4')
Switch Off	1 1 1 1	1	0	15 (X4Y4) & 15' (X4'Y4')
No Change	X X X X	0	X	X X X X

1 = High Level; 0 = Low Level; X = Don't Care

CONTROL TRUTH TABLE FOR CD22102

Function	Address	K _a	K _b	Select
	A B C D			
Switch On	1 1 1 1	1	0	15 (X4Y4) & 15' (X4'Y4')
Switch Off	1 1 1 1	0	1	15 (X4Y4) & 15' (X4'Y4')
All Switches Off [#]	X X X X	1	1	All
No Change	X X X X	0	0	X X X X

1 = High Level; 0 = Low Level; X = Don't Care

[#] In the event that K_a and K_b are changed from levels 1,1 to 0,0 K_b should not be allowed to go to 0 before K_a, otherwise a switch which was off will inadvertently be turned on.

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STATIC ELECTRICAL CHARACTERISTICS

LIMITS at Indicated Temperature (°C)												Units
CHARACTERISTIC	CONDITIONS	Values at -55,+25,+125,apply to D,F,H pkg										
		Values at -40,+25,+85,apply to E pkg										
		V _{IS} (V)	V _{DD} (V)	-55	-40	+85	+125	+25				
								Min.	Typ.	Max.		
CROSSPOINTS												
Quiescent Device Current, I _{DD} Max.		-	5	5	5	150	150	-	0.04	5	μA	
		-	10	10	10	300	300	-	0.04	10		
		-	15	20	20	600	600	-	0.04	20		
		-	20	100	100	3000	3000	-	0.08	100		
ON Resistance R _{ON} Max.	Any Switch V _{IS} = 0 to V _{DD}	-	5	475	500	725	800	-	225	600	Ω	
		-	10	135	145	205	230	-	85	180		
		-	12	100	110	155	175	-	75	135		
		-	15	70	75	110	125	-	65	95		
ΔON Resistance, ΔR _{ON}	Between any two switches	-	5	-	-	-	-	-	25	-	Ω	
		-	10	-	-	-	-	-	10	-		
		-	12	-	-	-	-	-	8	-		
		-	15	-	-	-	-	-	5	-		
OFF Leakage Current I _L Max.	All switches OFF	0,18	18	±1000				-	±1	±100*	nA	
CONTROLS												
Input Low Voltage V _{IL} Max.	OFF switch I _L <0.2 μA;	-	5	1.5				-	-	1.5	V	
		-	10	3				-	-	3		
		-	15	4				-	-	4		
Input High Voltage, V _{IH} Min.	ON switch see R _{ON} characteristic	-	5	3.5				3.5	-	-		
		-	10	7				7	-	-		
		-	15	11				11	-	-		
Input Current, I _{IN} Max.	Any control	0,18	18	±0.1	±0.1	±1	±1	-	±10 ⁻⁵	±0.1	μA	

* Determined by minimum feasible leakage measurement for automatic testing.

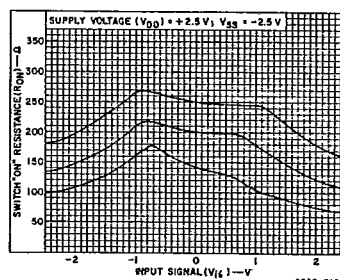
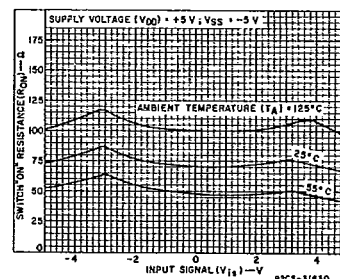
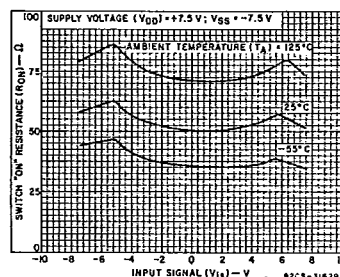
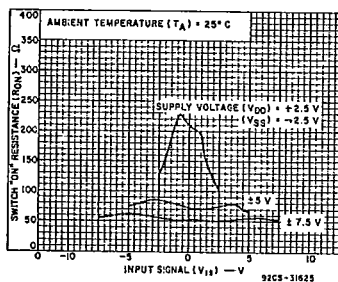
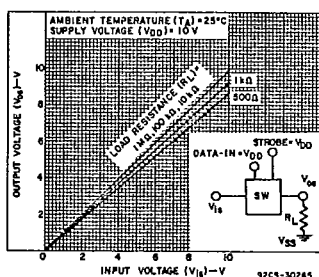
Fig. 3 - Typical ON resistance as a function of input signal voltage at $V_{DD} = -V_{SS} = 2.5$ V.Fig. 4 - Typical ON resistance as a function of input signal voltage at $V_{DD} = -V_{SS} = 5$ V.Fig. 5 - Typical ON resistance as a function of input signal voltage at $V_{DD} = -V_{SS} = 7.5$ V.Fig. 6 - Typical ON resistance as a function of input signal voltage at $T_A = 25^\circ C$.

Fig. 7 - Typical switch ON transfer characteristics (1 of 16 switches).

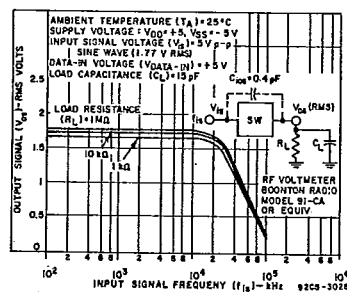


Fig. 8 - Typical switch ON frequency response characteristics.

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DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ\text{C}$

CHARACTERISTIC	CONDITIONS				LIMITS			UNITS
	f _{is} kHz	R _L kΩ	V _{is} ® (V)	V _{DD} (V)	Min.	Typ.	Max.	
CROSSPOINTS								
Propagation Delay Time, (Switch ON) Signal Input to Output, t _{PHL} , t _{PLH}	—	10	5 10 15	5 10 15	— — —	30 15 10	60 30 20	ns
	C _L = 50 pF; t _r , t _f = 20 ns							
Frequency Response, (Any Switch ON)	1	1	5	10	—	40	—	MHz
	Sine wave input, 20 log $\frac{V_{os}}{V_{is}}$ = -3 dB							
Sine Wave Response, (Distortion)	1 1 1	1 1 1	2.5 5 7.5	5 10 15	— — —	1 0.25 0.15	— — —	%
Feedthrough All Switches OFF (See Fig. 24)	1.6	0.6	2 [■]	10	—	-96	—	dB
	Sine wave input							
Frequency for Signal Crosstalk Attenuation of 40 dB	—	0.6	1 [■]	10	—	2.5	—	MHz
Attenuation of 95 dB (See Fig. 23)	Sine wave input					0.1		kHz
Capacitance, X _n to Ground Y _n to Ground Feedthrough		— — —	— — —	— — —	— — —	25 60 0.6	— — —	pF
CONTROLS			See Fig.					
Propagation Delay Time, High Impedance to High Level or Low Level, t _{PHZ} , t _{PLZ} Strobe to Output, CD22101	R _L = 1 kΩ, C _L = 50 pF, t _r , t _f = 20 ns			5 10 15	— — —	500 230 170	1000 460 340	ns
Data-In to Output, CD22101			16	5 10 15	— — —	515 220 170	1000 440 340	
K _a to Output, CD22102				5 10 15	— — —	500 215 160	1000 430 320	
Address to Output, CD22101, CD22102			18	5 10 15	— — —	480 225 155	960 450 300	
Propagation Delay Time, High Level or Low Level to High Impedance, t _{PHZ} , t _{PLZ} Strobe to Output, CD22101			16	5 10 15	— — —	450 200 135	900 400 270	
K _b to Output, CD22102				5 10 15	— — —	450 200 130	900 400 260	
Data-In to Output, CD22101				5 10 15	— — —	450 165 110	900 330 220	
K _a ·K _b to Output, CD22102				5 10 15	— — —	280 130 90	560 260 180	

* Peak-to-peak voltage symmetrical about V_{DD} unless otherwise specified.

■ RMS

2

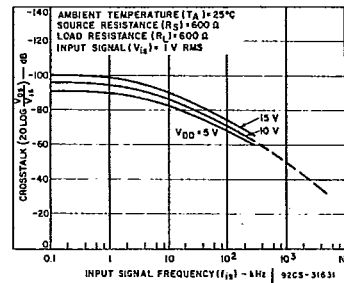


Fig. 9 — Typical crosstalk between switches as a function of signal frequency.

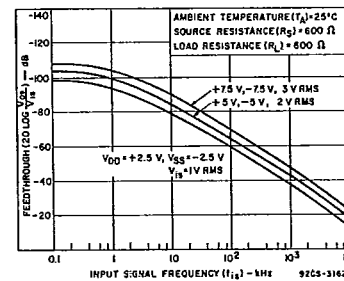


Fig. 10 — Typical feedthrough, any OFF switch as a function of frequency.

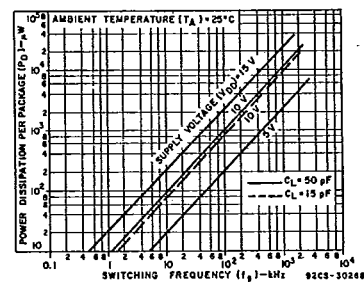
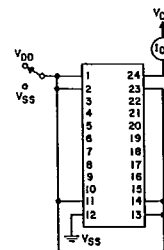


Fig. 11 — Typical dynamic power dissipation as a function of switching frequency for CD22101.



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Fig. 12 — Quiescent current test circuit.



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DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ\text{C}$ (cont'd)

CHARACTERISTIC	CONDITIONS				LIMITS			UNITS		
	f_{is} kHz	R_L k Ω	V_{is}^* (V)	V_{DD} (V)	Min.	Typ.	Max.			
CONTROLS (cont'd)			See Fig.							
Address to Output, CD22101, CD22102	$R_L = 1\text{ k},$ $C_L = 50\text{ pF},$ $t_r, t_f = 20\text{ ns}$ 	18	5 10 15	— — —	425 190 130	850 380 260	ns			
Minimum Strobe Pulse Width t_W CD22101			5 10 15	— — —	260 120 80	500 240 160				
Address to Strobe Setup or Hold Times, t_{SU}, t_H , CD22101		19	5 10 15	— — —	-160 -70 -50	0 0 0				
Strobe to Data-In Hold Time, Time, $t_{HL}; t_{LH}$, CD22101		20	5 10 15	— — —	200 80 60	400 160 120				
Address to K_a and K_b Setup or Hold Times, t_{SU}, t_H , CD22102			5 10 15	— — —	-160 -70 -50	0 0 0				
Minimum $K_a \cdot K_b$ Pulse Width, t_W CD22102			5 10 15	— — —	375 160 110	750 320 220				
Minimum K_a Pulse Width, t_W CD22102			5 10 15	— — —	425 175 120	850 350 240				
Minimum K_b Pulse Width, t_W CD22102			5 10 15	— — —	200 90 70	400 180 140				
Control Crosstalk, Data-In, Address, or Strobe to Output ¹		100	10	21	5	—		75	—	mv (peak)
		Square wave input = 5 V, $t_r, t_f = 20\text{ ns},$ $R_s = 1\text{ k}\Omega$								
Input Capacitance, C_{IN}		Any Control Input			—	—		5	7.5	pF

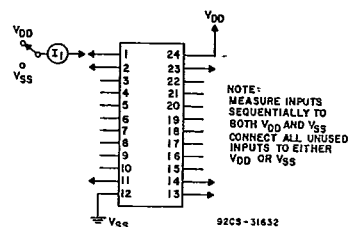


Fig. 13 - Input current test circuit.

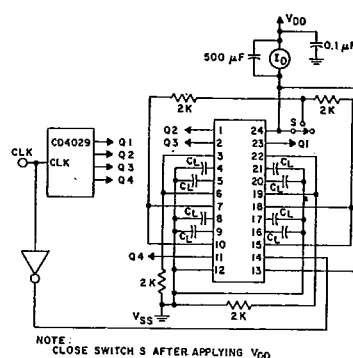


Fig. 14 - Dynamic power dissipation test circuit for CD22101.

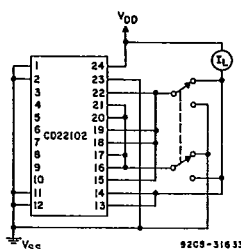


Fig. 15 - OFF switch input or output leakage current test circuit (16 of 32 switches).

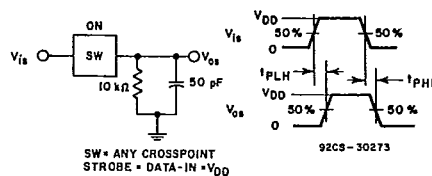


Fig. 16 - Propagation delay time test circuit and waveforms (signal input to signal output, switch ON).

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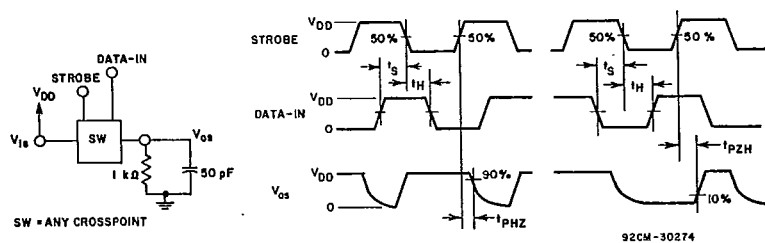


Fig. 17 - Propagation delay time test circuit and waveforms (strobe to signal output, switch Turn-ON or Turn-OFF).

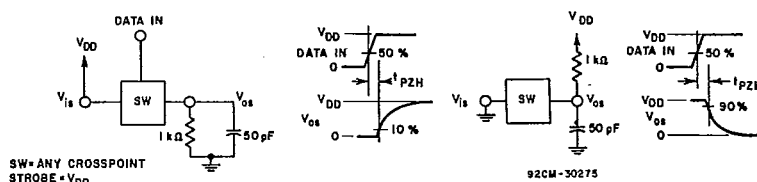


Fig. 18 - Propagation delay time test circuit and waveforms (data-in to signal output, switch Turn-ON to high or low level).

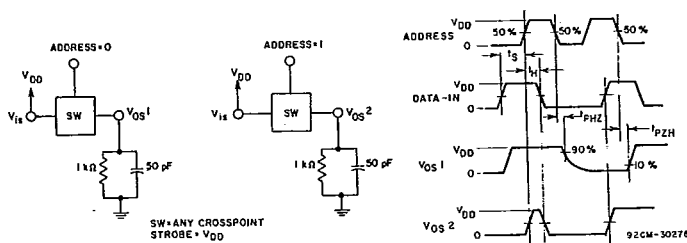


Fig. 19 - Propagation delay time test circuit and waveforms (address to signal output, switch turn-ON or Turn-OFF).

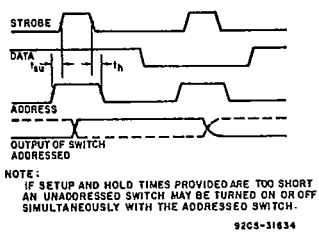


Fig. 20 - Address to strobe setup and hold times.

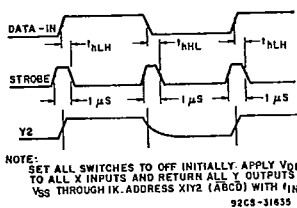


Fig. 21 - Strobe to Data-In hold time t_H for CD22101.

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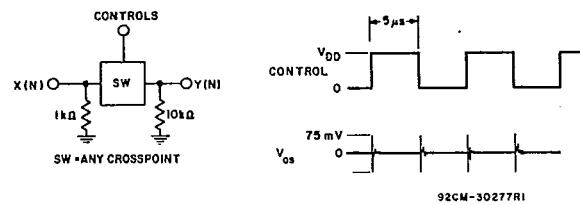


Fig. 22 - Test circuit and waveforms for crosstalk (control input to signal output).

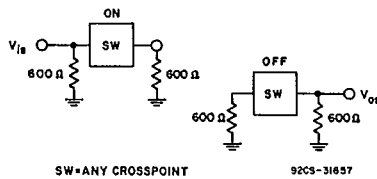


Fig. 23 - Test circuit for crosstalk between switch circuits in the same package.

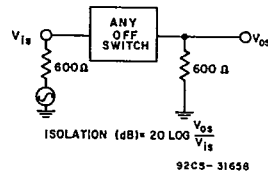
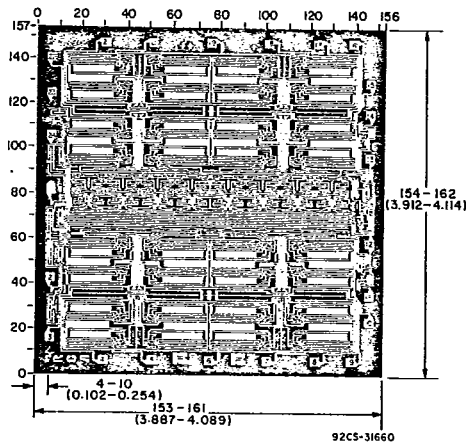
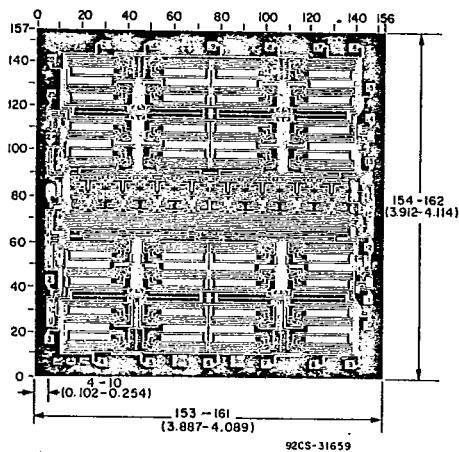


Fig. 24 - Test circuit for feedthrough (any OFF switch).



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