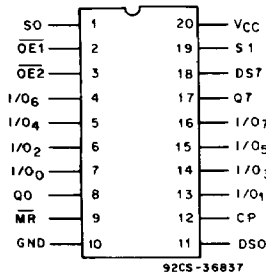


CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

Advance Information



TERMINAL ASSIGNMENT

8-Input Universal Shift/Storage Register with Common Parallel I/O Pins

CD54/74AC/ACT299 - Asynchronous Reset
CD54/74AC/ACT323 - Synchronous Reset

Type Features:

- Buffered inputs
- Typical propagation delay:
6 ns @ $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$, $C_L = 50\text{ pF}$

The RCA CD54/74AC299 and CD54/74AC323 and the CD54/74ACT299 and CD54/74ACT323 are 3-state, 8-input universal shift/storage registers with common parallel I/O pins. These devices use the RCA ADVANCED CMOS technology. These registers have four synchronous-operating modes controlled by the two select inputs as shown in the Mode Select (S0, S1) table. The Mode Select, the Serial Data (DSO, DS7), and the Parallel Data (I/O₀ - I/O₇) respond only to the LOW-TO-HIGH transition of the clock (CP) pulse. S0, S1 and Data inputs must be present one setup time prior to the positive transition of the clock.

With the CD54/74AC/ACT299, the Master Reset ($\overline{\text{MR}}$) is an asynchronous active-LOW input. When $\overline{\text{MR}}$ is LOW, the register is cleared regardless of the status of all other inputs. With the CD54/74AC/ACT323, the Master Reset ($\overline{\text{MR}}$) clears the register in sync with the clock input. The register can be expanded by cascading same units by tying the serial output (Q0) to the serial data (DS7) input of the preceding register, and tying the serial output (Q7) to the serial data (DSO) input of the following register. Recirculating the (n x 8) bits is accomplished by tying the Q7 of the last stage to the DSO of the first stage.

The 3-state input/output (I/O) port has three modes of operation:

1. Both Output Enable ($\overline{\text{OE1}}$ and $\overline{\text{OE2}}$) inputs are LOW and S0 or S1 or both are LOW; the data in the register is present at the eight outputs.
2. When both S0 and S1 are HIGH, I/O terminals are in the high-impedance state but being input ports, ready for parallel data to be loaded into eight registers with one clock transition regardless of the status of $\overline{\text{OE1}}$ and $\overline{\text{OE2}}$.

Family Features:

- Exceeds 2-kV ESD Protection - MIL-STD-883, Method 3015
- SCR-Latchup-resistant CMOS process and circuit design
- Speed of bipolar FAST[®]/AS/S with significantly reduced power consumption
- Balanced propagation delays
- AC types feature 1.5-V to 5.5-V operation and balanced noise immunity at 30% of the supply
- $\pm 24\text{-mA}$ output drive current
 - Fanout to 15 FAST[®] ICs
 - Drives 50-ohm transmission lines

**FAST is a Registered Trademark of Fairchild Semiconductor Corp.*

3. Either one of the two Output Enable inputs being HIGH will force I/O terminals to be in the off state. It is noted that each I/O terminal is a 3-state output and a CMOS buffer input.

The CD74AC/ACT299 and CD74AC/ACT323 are supplied in 20-lead dual-in-line plastic packages (E suffix) and in 20-lead dual-in-line small-outline plastic packages (M suffix). Both package types are operable over the following temperature ranges: Commercial (0 to 70°C); Industrial (-40 to +85°C); and Extended Industrial/Military (-55 to +125°C).

The CD54AC/ACT299 and CD54AC/ACT323, available in chip form (H suffix), are operable over the -55 to +125°C temperature range.

9

CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

MODE SELECT — FUNCTION TABLE REGISTER OPERATING MODES

FUNCTION	INPUTS							REGISTER OUTPUTS						
	MR	CP	S0	S1	DS0	DS7	I/O _n	Q0	Q1	...	Q6	Q7		
Reset (Clear)	L	X*	X	X	X	X	X	L	L	...	L	L		
Shift Right	H		h	l	l	X	X	L	Q ₀	...	Q ₆	Q ₆		
	H		h	l	h	X	X	H	Q ₀	...	Q ₆	Q ₆		
Shift Left	H		l	h	X	l	X	Q ₁	Q ₂	...	Q ₇	L		
	H		l	h	X	h	X	Q ₁	Q ₂	...	Q ₇	H		
Hold (do nothing)	H		l	l	X	X	X	Q ₀	Q ₁	...	Q ₆	Q ₇		
Parallel Load	H		h	h	X	X	l	L	L	...	L	L		
	H		h	h	X	X	h	H	H	...	H	H		

*On CD54/74AC/ACT323, CP must be in transition from the LOW-to-HIGH state to Reset (Clear).

MODE SELECT — FUNCTION TABLE 3-STATE I/O PORT OPERATING MODE

FUNCTION	INPUTS				Q _n (Register)	I/O ₀ ... I/O ₇
	OE1	OE2	S0	S1		
Read Register	L	L	L	X	L	L
	L	L	L	X	H	H
	L	L	X	L	L	L
	L	L	X	L	H	H
Load Register	X	X	H	H	Q _n = I/O _n	I/O _n = Inputs
Disable I/O	H	X	X	X	X	(Z)
	X	H	X	X	X	(Z)

H = Input voltage high level.

h = Input voltage high one set-up time prior clock transition.

L = Input voltage low level.

l = Input voltage low one set-up time prior clock transition.

q_n = Lower case letters indicate the state of the referenced output one set-up time prior clock transition.

X = Voltage level on logic status don't care.

Z = Output in high-impedance state.

= Low-to-high clock transition.

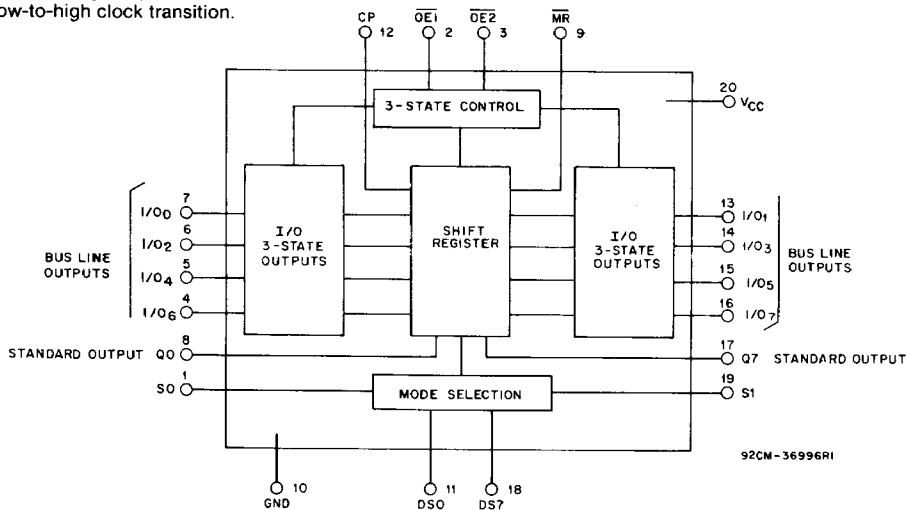


Fig. 1 - Functional diagram.

CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE (V_{CC})	.....	-0.5 to 6 V
DC INPUT DIODE CURRENT, I_{IK} (for $V_i < -0.5$ V or $V_i > V_{CC} + 0.5$ V)	± 20 mA
DC OUTPUT DIODE CURRENT, I_{OK} (for $V_o < -0.5$ V or $V_o > V_{CC} + 0.5$ V)	± 50 mA
DC OUTPUT SOURCE OR SINK CURRENT per Output Pin, I_o (for $V_o > -0.5$ V or $V_o < V_{CC} + 0.5$ V)	± 50 mA
DC V_{CC} or GROUND CURRENT (I_{CC} or I_{GND})	± 100 mA*
POWER DISSIPATION PER PACKAGE (P_D):		
For $T_A = -55$ to $+100^\circ\text{C}$ (PACKAGE TYPE E)	.....	500 mW
For $T_A = +100$ to $+125^\circ\text{C}$ (PACKAGE TYPE E)	.....	Derate Linearly at 8 mW/ $^\circ\text{C}$ to 300 mW
For $T_A = -55$ to $+70^\circ\text{C}$ (PACKAGE TYPE M)	.....	400 mW
For $T_A = +70$ to $+125^\circ\text{C}$ (PACKAGE TYPE M)	.....	Derate Linearly at 6 mW/ $^\circ\text{C}$ to 70 mW
OPERATING-TEMPERATURE RANGE (T_A)	.....	-55 to $+125^\circ\text{C}$
STORAGE TEMPERATURE (T_{stg})	.....	-65 to $+150^\circ\text{C}$
LEAD TEMPERATURE (DURING SOLDERING):		
At distance $1/16 \pm 1/32$ in. (1.59 ± 0.79 mm) from case for 10 s maximum	.....	$+265^\circ\text{C}$
Unit inserted into PC board min. thickness $1/16$ in. (1.59 mm) with solder contacting lead tips only	.....	$+300^\circ\text{C}$

*For up to 4 outputs per device; add ± 25 mA for each additional output.

RECOMMENDED OPERATING CONDITIONS:

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

CHARACTERISTICS	LIMITS		UNITS
	MIN.	MAX.	
Supply-Voltage Range, V_{CC} *: (For $T_A =$ Full Package-Temperature Range) AC Types ACT Types	1.5 4.5	5.5 5.5	V V
DC Input or Output Voltage, V_i, V_o	0	V_{CC}	V
Operating Temperature, T_A	-55	+125	$^\circ\text{C}$
Input Rise and Fall Slew Rate, dt/dv at 1.5 V to 3 V (AC Types) at 3.6 V to 5.5 V (AC Types) at 4.5 V to 5.5 V (ACT Types)	0 0 0	50 20 10	ns/V ns/V ns/V

*Unless otherwise specified, all voltages are referenced to ground.

CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

STATIC ELECTRICAL CHARACTERISTICS: AC Series

CHARACTERISTICS	TEST CONDITIONS		V _{CC} (V)	AMBIENT TEMPERATURE (T _A) - °C						UNITS	
				+25		-40 to +85		-55 to +125			
	V _i (V)	I _o (mA)		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
High-Level Input Voltage	V _{IH}		1.5	1.2	—	1.2	—	1.2	—	V	
			3	2.1	—	2.1	—	2.1	—		
			5.5	3.85	—	3.85	—	3.85	—		
Low-Level Input Voltage	V _{IL}		1.5	—	0.3	—	0.3	—	0.3	V	
			3	—	0.9	—	0.9	—	0.9		
			5.5	—	1.65	—	1.65	—	1.65		
High-Level Output Voltage	V _{OH}	V _{IH} or V _{IL}	-0.05	1.5	1.4	—	1.4	—	1.4	V	
			-0.05	3	2.9	—	2.9	—	2.9		
			-0.05	4.5	4.4	—	4.4	—	4.4		
			-4	3	2.58	—	2.48	—	2.4		
			-24	4.5	3.94	—	3.8	—	3.7		
			-75	5.5	—	—	3.85	—	—		
			-50	5.5	—	—	—	—	3.85		
Low-Level Output Voltage	V _{OL}	V _{IH} or V _{IL}	0.05	1.5	—	0.1	—	0.1	—	V	
			0.05	3	—	0.1	—	0.1	—		
			0.05	4.5	—	0.1	—	0.1	—		
			12	3	—	0.36	—	0.44	—		0.5
			24	4.5	—	0.36	—	0.44	—		0.5
			75	5.5	—	—	—	1.65	—		—
			50	5.5	—	—	—	—	—		1.65
Input Leakage Current	I _i	V _{CC} or GND	5.5	—	±0.1	—	±1	—	±1	μA	
3-Stage Leakage Current	I _{oz}	V _{IH} or V _{IL} V _O = V _{CC} or GND	5.5	—	±0.5	—	±5	—	±10	μA	
Quiescent Supply Current, MSI	I _{CC}	V _{CC} or GND	0	5.5	—	8	—	80	—	160	μA

#Test one output at a time for a 1-second maximum duration. Measurement is made by forcing current and measuring voltage to minimize power dissipation.

*Test verifies a minimum 50-ohm transmission-line-drive capability at +85°C, 75 ohms at +125°C.

CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

STATIC ELECTRICAL CHARACTERISTICS: ACT Series

CHARACTERISTICS	TEST CONDITIONS	V_{CC} (V)	AMBIENT TEMPERATURE (T_A) - °C						UNITS		
			+25		-40 to +85		-55 to +125				
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.			
High-Level Input Voltage	V_{IH}		4.5 to 5.5	2	—	2	—	2	—	V	
Low-Level Input Voltage	V_{IL}		4.5 to 5.5	—	0.8	—	0.8	—	0.8	V	
High-Level Output Voltage	V_{OH}	V_{IH} or V_{IL} #, *	-0.05	4.5	4.4	—	4.4	—	4.4	—	V
			-24	4.5	3.94	—	3.8	—	3.7	—	
			-75	5.5	—	—	3.85	—	—	—	
			-50	5.5	—	—	—	—	3.85	—	
Low-Level Output Voltage	V_{OL}	V_{IH} or V_{IL} #, *	0.05	4.5	—	0.1	—	0.1	—	0.1	V
			24	4.5	—	0.36	—	0.44	—	0.5	
			75	5.5	—	—	—	1.65	—	—	
			50	5.5	—	—	—	—	—	1.65	
Input Leakage Current	I_I	V_{CC} or GND	5.5	—	±0.1	—	±1	—	±1	µA	
3-State Leakage Current	I_{OZ}	V_{IH} or V_{IL} V_O V_{CC} or GND	5.5	—	±0.5	—	±5	—	±10	µA	
Quiescent Supply Current, MSI	I_{CC}	V_{CC} or GND	0	5.5	—	8	—	80	—	160	µA
Additional Quiescent Supply Current per Input Pin TTL Inputs High 1 Unit Load	ΔI_{CC}	$V_{CC}-2.1$	4.5 to 5.5	—	2.4	—	2.8	—	3	mA	

#Test one output at a time for a 1-second maximum duration. Measurement is made by forcing current and measuring voltage to minimize power dissipation.

*Test verifies a minimum 50-ohm transmission-line-drive capability at +85°C, 75 ohms at +125°C.

ACT INPUT LOADING TABLE

INPUT	UNIT LOADS*	
	299	323
S1, S0, $\overline{OE1}$, $\overline{OE2}$	0.83	0.83
I/O ₀ - I/O ₇ , CP, DS0, DS7	0.67	0.67
MR	1.33	0.67

*Unit load is ΔI_{CC} limit specified in Static Characteristics Chart, e.g., 2.4 mA max. @ 25°C.

9

CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

PREREQUISITE FOR SWITCHING: AC Series

CHARACTERISTICS	SYMBOL	V _{CC} (V)	AMBIENT TEMPERATURE (T _A) - °C				UNITS
			-40 to +85		-55 to +125		
			MIN.	MAX.	MIN.	MAX.	
Setup Time S1, S0, to CP	t _{SU}	1.5	99	—	113	—	ns
		3.3*	11.1	—	12.6	—	
		5†	7.9	—	9	—	
Hold Time S1, S0 to CP	t _H	1.5	0	—	0	—	ns
		3.3	0	—	0	—	
		5	0	—	0	—	
Setup Time (I/O) _n , DS0, DS7 to CP	t _{SU}	1.5	49	—	56	—	ns
		3.3	5.5	—	6.3	—	
		5	3.9	—	4.5	—	
Hold Time (I/O) _n , DS0, DS7 to CP	t _{SU}	1.5	0	—	0	—	ns
		3.3	0	—	0	—	
		5	0	—	0	—	
Setup Time MR to CP (323)	t _{SU}	1.5	61	—	69	—	ns
		3.3	6.8	—	7.8	—	
		5	4.8	—	5.5	—	
Hold Time MR to CP (323)	t _H	1.5	0	—	0	—	ns
		3.3	0	—	0	—	
		5	0	—	0	—	
Maximum CP Frequency	f _{MAX}	1.5	9	—	8	—	MHz
		3.3	78	—	68	—	
		5	108	—	95	—	
CP Pulse Width	t _w	1.5	57	—	65	—	ns
		3.3	6.4	—	7.3	—	
		5	4.6	—	5.2	—	
MR Pulse Width	t _w	1.5	55	—	63	—	ns
		3.3	6.1	—	7	—	
		5	4.4	—	5	—	
Recovery Time MR to CP 299	t _{REC}	1.5	55	—	63	—	ns
		3.3	6.1	—	7	—	
		5	4.4	—	5	—	

*3.3 V: min. is @ 3 V

†5 V: min is @ 4.5 V

CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

SWITCHING CHARACTERISTICS: AC Series; $t_r, t_f = 3 \text{ ns}$, $C_L = 50 \text{ pF}$

CHARACTERISTICS	SYMBOL	V_{CC} (V)	AMBIENT TEMPERATURE (T_A) - °C				UNITS
			-40 to +85		-55 to +125		
			MIN.	MAX.	MIN.	MAX.	
Propagation Delays: CP to Q0, Q7	t_{PLH}	1.5 3.3*	— 4.7	147 16.5	— 4.5	162 18.1	ns
	t_{PHL}	5†	3.3	11.7	3.2	12.9	
CP to (I/O)n	t_{PLH}	1.5	—	154	—	169	ns
	t_{PHL}	3.3 5	4.9 3.5	17.2 12.3	4.7 3.4	18.9 13.5	
MR to Q0, Q7 (299 only)	t_{PLH}	1.5	—	127	—	140	ns
	t_{PHL}	3.3 5	4 2.9	14.3 10.2	3.9 2.8	15.7 11.2	
MR to (I/O)n	t_{PLH}	1.5	—	158	—	174	ns
	t_{PHL}	3.3 5	5 3.6	17.7 12.6	4.9 3.5	19.5 13.9	
Enable and Disable Times	t_{PZL}	1.5	—	169	—	186	ns
	t_{PZH}	3.3	5.8	20.4	5.6	22.4	
	t_{PLZ}	5	3.8	13.5	3.7	14.9	
	t_{PHZ}	5	3.8	13.5	3.7	14.9	
Power Dissipation Capacitance	$C_{PD}\S$	—	280 Typ.		280 Typ.		pF
Input Capacitance	C_i	—	—	10	—	10	pF
3-State Output Capacitance	C_o	—	—	15	—	15	pF

*3.3 V: min. is @ 3.6 V
max. is @ 3 V

†5 V: min. is @ 5.5 V
max. is @ 4.5 V

§ C_{PD} is used to determine the dynamic power consumption, per function.

$P_D = C_{PD}V_{CC}^2 f_i + \Sigma (C_L V_{CC}^2 f_o)$ where f_i = input frequency
 f_o = output frequency
 C_L = output load capacitance
 V_{CC} = supply voltage.

PREREQUISITE FOR SWITCHING: ACT Series

CHARACTERISTICS	SYMBOL	V_{CC} (V)	AMBIENT TEMPERATURE (T_A) - °C				UNITS
			-40 to +85		-55 to +125		
			MIN.	MAX.	MIN.	MAX.	
Setup Time S1, S0 to CP	t_{SU}	5*	7.9	—	9	—	ns
Hold Time S1, S0 to CP	t_H	5	0	—	0	—	ns
Setup Time (I/O)n, DS0, DS7 to CP	t_{SU}	5	3.9	—	4.5	—	ns
Hold Time (I/O)n, DS0, DS7 to CP	t_H	5	0	—	0	—	ns
Setup Time MR to CP (323)	t_{SU}	5*	4.8	—	5.5	—	ns
Hold Time MR to CP (323)	t_H	5	0	—	0	—	ns
Maximum CP Frequency	f_{max}	5	103	—	90	—	MHz
CP Pulse Width	t_w	5	4.8	—	5.5	—	ns
MR Pulse Width	t_w	5	4.4	—	5	—	ns
Recovery Time MR to CP (299)	t_{REC}	5	4.4	—	5	—	ns

*5 V: min. is @ 4.5 V

9

CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

SWITCHING CHARACTERISTICS: ACT Series; $t_r, t_f = 3 \text{ ns}$, $C_L = 50 \text{ pF}$

CHARACTERISTICS	SYMBOL	V_{CC} (V)	AMBIENT TEMPERATURE (T_A) - °C				UNITS
			-40 to +85		-55 to +125		
			MIN.	MAX.	MIN.	MAX.	
Propagation Delays: CP to Q0, Q7	t_{PLH} t_{PHL}	5*	3.3	11.7	3.2	12.9	ns
CP to (I/O)n	t_{PLH} t_{PHL}	5	3.7	13.2	3.6	14.5	ns
MR to Q0, Q7 (299 only)	t_{PLH} t_{PHL}	5	3.1	11.1	3.1	12.2	ns
MR to (I/O)n	t_{PLH} t_{PHL}	5	4.8	16.9	4.7	18.6	ns
Enable and Disable Times	t_{PLZ} t_{PHZ} t_{PZL} t_{PZH}	5	3.8	13.5	3.7	14.9	ns
Power Dissipation Capacitance	$C_{PD}\$$	—	280 Typ.		280 Typ.		pF
Input Capacitance	C_I	—	—	10	—	10	pF
3-State Output Capacitance	C_O	—	—	15	—	15	pF

*5 V: min. is @ 5.5 V
max. is @ 4.5 V

$\$C_{PD}$ is used to determine the dynamic power consumption, per function.
 $P_D = C_{PD}V_{CC}^2 f_i + \sum (C_L V_{CC}^2 f_o) + V_{CC}\Delta I_{CC}$ where f_i = input frequency
 f_o = output frequency
 C_L = output load capacitance
 V_{CC} = supply voltage.

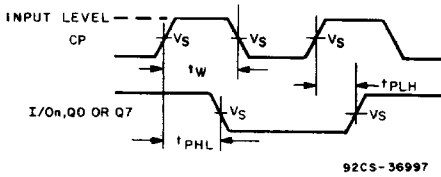


Fig. 2 - Clock prerequisite and propagation delays.

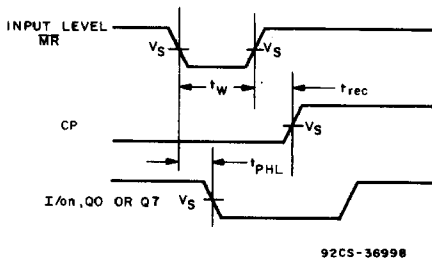
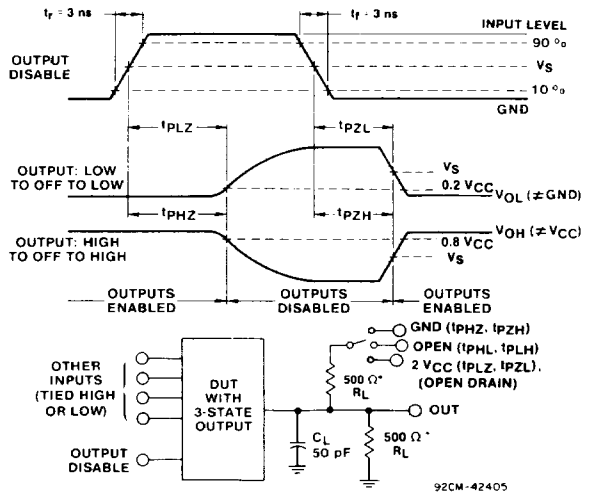


Fig. 3 - Master Reset prerequisite and propagation delays.



*FOR AC SERIES ONLY: WHEN $V_{CC} = 1.5 \text{ V}$, $R_L = 1 \text{ k}\Omega$

Fig. 4 - Three-state propagation delay times and test circuit.

CD54/74AC299, CD54/74AC323 CD54/74ACT299, CD54/74ACT323

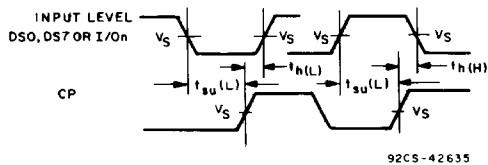
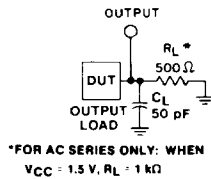


Fig. 5 - Data prerequisite times.



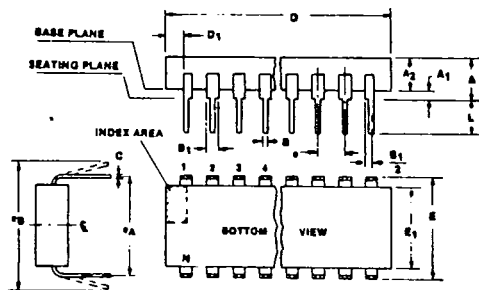
*FOR AC SERIES ONLY: WHEN
 $V_{CC} = 1.5\ \text{V}, R_L = 1\ \text{k}\Omega$

Fig. 6 - Test circuit.

	CD54/74AC	CD54/74ACT
Input Level	V_{CC}	3 V
Input Switching Voltage, V_s	$0.5 V_{CC}$	1.5 V
Output Switching Voltage, V_s	$0.5 V_{CC}$	$0.5 V_{CC}$

Dual-In-Line Plastic Packages

T-90-20



Notes:

1. Refer to JEDEC Publication No. 95 JEDEC Registered and Standard Outlines for Solid State Products, for rules and general information concerning registered and standard outlines, in Section 2.2.
2. Protrusions (flash) on the base plane surface shall not exceed 0.010 in. (0.25 mm).
3. The dimension shown is for full leads. "Half" leads are optional at lead positions $1, N, \frac{N}{2}, \frac{N}{2} + 1$.
4. Dimension D does not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 in. (0.25 mm).
5. E is the dimension to the outside of the leads and is measured with the leads perpendicular to the base plane (zero lead spread).
6. Dimension E₁ does not include mold flash or protrusions.
7. Package body and leads shall be symmetrical around center line shown in end view.
8. Lead spacing e shall be non-cumulative and shall be measured at the lead tip. This measurement shall be made before insertion into gauges, boards or sockets.
9. This is a basic installed dimension. Measurement shall be made with the device installed in the seating plane gauge (JEDEC Outline No. GS-3, seating plane gauge). Leads shall be in true position within 0.010 in. (0.25 mm) diameter for dimension e_A.
10. e_B is the dimension to the outside of the leads and is measured at the lead tips before the device is installed. Negative lead spread is not permitted.
11. N is the maximum number of lead positions.
12. Dimension D₁ at the left end of the package must equal dimension D₁ at the right end of the package within 0.030 in. (0.76 mm).
13. For automatic insertion, any raised irregularity on the top surface (step, mesa, etc.) shall be symmetrical about the lateral and longitudinal package centerlines.

(E) Suffix (JEDEC MS-001-AC)
14-Lead Dual-In-Line Plastic Package

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.210	—	5.33	9
A ₁	0.015	—	0.39	—	9
A ₂	0.115	0.195	2.93	4.95	
B	0.014	0.022	0.356	0.558	
B ₁	0.045	0.070	1.15	1.77	3
C	0.008	0.015	0.204	0.381	
D	0.725	0.795	18.42	20.19	4
D ₁	0.005	—	0.13	—	12
E	0.300	0.325	7.62	8.25	5
E ₁	0.240	0.280	6.10	7.11	6, 7
e	0.100 BSC		2.54 BSC		8
e _A	0.300 BSC		7.62 BSC		9
e _B	—	0.430	—	10.92	10
L	0.115	0.160	2.93	4.06	9
N	14		14		11

92CS-39901

(E) Suffix (JEDEC MS-001-AA)
16-Lead Dual-In-Line Plastic Package

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.210	—	5.33	9
A ₁	0.015	—	0.39	—	9
A ₂	0.115	0.195	2.93	4.95	
B	0.014	0.022	0.356	0.558	
B ₁	0.045	0.070	1.15	1.77	3
C	0.008	0.015	0.204	0.381	
D	0.745	0.840	18.93	21.33	4
D ₁	0.005	—	0.13	—	12
E	0.300	0.325	7.62	8.25	5
E ₁	0.240	0.280	6.10	7.11	6, 7
e	0.100 BSC		2.54 BSC		8
e _A	0.300 BSC		7.62 BSC		9
e _B	—	0.430	—	10.92	10
L	0.115	0.160	2.93	4.06	9
N	16		16		11

92CS-39900

(E) Suffix (JEDEC MS-001-AE)
20-Lead Dual-In-Line Plastic Package

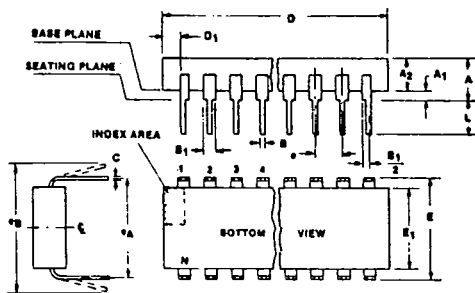
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.210	—	5.33	9
A ₁	0.015	—	0.39	—	9
A ₂	0.115	0.195	2.93	4.95	
B	0.014	0.022	0.356	0.558	
B ₁	0.045	0.070	1.15	1.77	3
C	0.008	0.015	0.204	0.381	
D	0.925	1.060	23.5	26.9	4
D ₁	0.005	—	0.13	—	12
E	0.300	0.325	7.62	8.25	5
E ₁	0.240	0.280	6.10	7.11	6, 7
e	0.100 BSC		2.54 BSC		8
e _A	0.300 BSC		7.62 BSC		9
e _B	—	0.430	—	10.92	10
L	0.115	0.160	2.93	4.06	9
N	20		20		11

92CS-39997

Dual-In-Line Plastic Packages

T-90-20

(E) Suffix (JEDEC MS-001-AF)
24-Lead Dual-In-Line Plastic Package



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.210	—	5.33	9
A ₁	0.015	—	0.39	—	9
A ₂	0.115	0.195	2.93	4.95	
B	0.014	0.022	0.356	0.558	
B ₁	0.045	0.070	1.15	1.77	3
C	0.008	0.015	0.204	0.381	
D	1.125	1.275	28.6	32.3	4
D ₁	0.005	—	0.13	—	12
E	0.300	0.325	7.62	8.25	5
E ₁	0.240	0.280	6.10	7.11	6, 7
e	0.100 BSC		2.54 BSC		8
e _A	0.300 BSC		7.62 BSC		9
e _B	—	0.430	—	10.92	10
L	0.115	0.160	2.93	4.06	9
N	24		24		11

92CS-39943

Notes:

1. Refer to JEDEC Publication No. 95 JEDEC Registered and Standard Outlines for Solid State Products, for rules and general information concerning registered and standard outlines, in Section 2.2.
2. Protrusions (flash) on the base plane surface shall not exceed 0.010 in. (0.25 mm).
3. The dimension shown is for full leads. "Half" leads are optional at lead positions

$$1, N, \frac{N}{2}, \frac{N}{2} + 1.$$
4. Dimension D does not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 in. (0.25 mm).
5. E is the dimension to the outside of the leads and is measured with the leads perpendicular to the base plane (zero lead spread).
6. Dimension E₁ does not include mold flash or protrusions.
7. Package body and leads shall be symmetrical around

center line shown in end view.

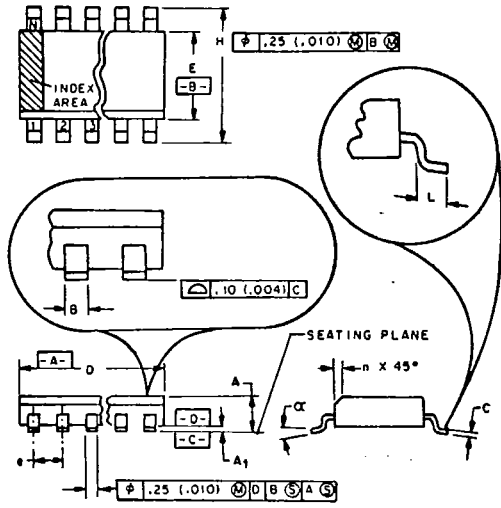
8. Lead spacing e shall be non-cumulative and shall be measured at the lead tip. This measurement shall be made before insertion into gauges, boards or sockets.
9. This is a basic installed dimension. Measurement shall be made with the device installed in the seating plane gauge (JEDEC Outline No. GS-3, seating plane gauge). Leads shall be in true position within 0.010 in. (0.25 mm) diameter for dimension e_A.
10. e_B is the dimension to the outside of the leads and is measured at the lead tips before the device is installed. Negative lead spread is not permitted.
11. N is the maximum number of lead positions.
12. Dimension D₁ at the left end of the package must equal dimension D₁ at the right end of the package within 0.030 in. (0.76 mm).
13. For automatic insertion, any raised irregularity on the top surface (step, mesa, etc.) shall be symmetrical about the lateral and longitudinal package centerlines.

13

Dimensional Outlines

Dual-In-Line Small-Outline Plastic Packages

T-90-20



NOTES:

1. Refer to applicable symbol list.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. "D" is a reference datum.
4. "A" and "B" are reference datums and do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm (0.006 in.).
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the cross-hatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. Controlling dimensions: MILLIMETERS.

M Suffix (JEDEC MS-012AB)
14-Lead Dual-In-Line Small-Outline (SO) Package

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.0532	0.0688	1.35	1.75	
A ₁	0.0040	0.0098	0.10	0.25	
B	0.0138	0.020	0.35	0.508	
C	0.0075	0.0098	0.19	0.25	
D	0.3367	0.3444	8.55	8.75	4
E	0.1497	0.1574	3.80	4.00	4
e	0.050 BSC		1.27 BSC		
H	0.2284	0.2440	5.80	6.20	
h	0.0099	0.0196	0.25	0.50	5
L	0.016	0.050	0.40	1.27	6
N	14		14		7
α	0° 8°		0° 8°		

Notes: 1, 2, 3, 8, 9

92CS-38924R2

M Suffix (JEDEC MS-012AC)
16-Lead Dual-In-Line Small-Outline (SO) Package

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.0532	0.0688	1.35	1.75	
A ₁	0.0040	0.0098	0.10	0.25	
B	0.0138	0.020	0.35	0.508	
C	0.0075	0.0098	0.19	0.25	
D	0.3859	0.3937	9.80	10.00	4
E	0.1497	0.1574	3.80	4.00	4
e	0.050 BSC		1.27 BSC		
H	0.2284	0.2440	5.80	6.20	
h	0.0099	0.0196	0.25	0.50	5
L	0.016	0.050	0.40	1.27	6
N	16		16		7
α	0° 8°		0° 8°		

Notes: 1, 2, 3, 8, 9

92CS-38925R2

M Suffix (JEDEC MS-013AC)
20-Lead Dual-In-Line Small-Outline (SO) Package

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.0926	0.1043	2.35	2.65	
A ₁	0.0040	0.0118	0.10	0.30	
B	0.0138	0.020	0.35	0.508	
C	0.0091	0.0125	0.23	0.32	
D	0.4861	0.5118	12.60	13.00	4
E	0.2914	0.2992	7.40	7.60	4
e	0.050 BSC		1.27 BSC		
H	0.394	0.419	10.00	10.65	
h	0.010	0.029	0.25	0.75	5
L	0.016	0.050	0.40	1.27	6
N	20		20		7
α	0° 8°		0° 8°		

Notes: 1, 2, 3, 8, 9

92CS-38926R2

M Suffix (JEDEC MS-013AD)
24-Lead Dual-In-Line Small-Outline (SO) Package

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.0926	0.1043	2.35	2.65	
A ₁	0.0040	0.0118	0.10	0.30	
B	0.0138	0.020	0.35	0.508	
C	0.0091	0.0125	0.23	0.32	
D	0.5985	0.6141	15.20	15.60	4
E	0.2914	0.2992	7.40	7.60	4
e	0.050 BSC		1.27 BSC		
H	0.394	0.419	10.00	10.65	
h	0.010	0.029	0.25	0.75	5
L	0.016	0.050	0.40	1.27	6
N	24		24		7
α	0° 8°		0° 8°		

Notes: 1, 2, 3, 8, 9

92CS-39037R2