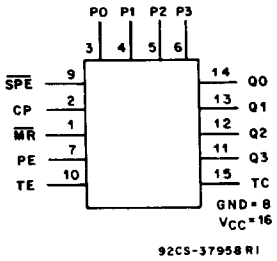
Advance Information

CD54/74AC161, CD54/74AC163
CD54/74ACT161, CD54/74ACT163



FUNCTIONAL DIAGRAM

Synchronous Presettable Binary Counters

CD54/74AC/ACT161 - Asynchronous Reset
CD54/74AC/ACT163 - Synchronous Reset

Type Features:

- *Buffered inputs*
- *Typical propagation delay:*
  7.8 ns @ V_{CC} = 5 V, T_A = 25° C, C_L = 50 pF

The RCA CD54/74AC161 and CD54/74AC163 and the CD54/74ACT161 and CD54/74ACT163 synchronous presettable binary counters use the RCA ADVANCED CMOS technology. The CD54/74AC/ACT161 are asynchronously reset; the CD54/74AC/ACT163 devices are reset synchronously with the clock. Counting and parallel presetting are both accomplished synchronously with the negative-to-positive transition of the clock.

A LOW level on the Synchronous Parallel Enable input, $\overline{SPE}$, disables the counting operation and allows data at the P0 to P3 inputs to be loaded into the counter (provided that the setup and hold requirements for $\overline{SPE}$ are met).

The counters are reset with a LOW level on the Master Reset input, $\overline{MR}$. In the CD54/74AC/ACT163 counter (synchronous reset), the requirements for setup and hold time with respect to the clock must be met.

Two count enables, PE and TE, in each counter are provided for n-bit cascading. Reset action occurs regardless of the level of the $\overline{SPE}$, PE, and TE inputs (and the clock input, CP, in the CD54/74AC/ACT161).

The look-ahead carry feature simplifies serial cascading of the counters. Both count enable inputs (PE and TE) must be HIGH to count. The TE input is gated with the Q outputs of all four stages so that at the maximum count, the terminal count (TC) output goes HIGH for one clock period. This TC pulse is used to enable the next cascaded stage.

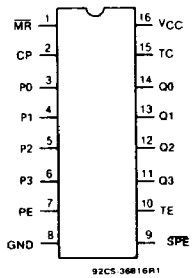
The CD74AC/ACT161 and CD74AC/ACT163 are supplied in 16-lead dual-in-line plastic packages (E suffix) and in 16-lead dual-in-line small-outline plastic packages (M suffix). Both package types are operable over the following temperature ranges: Commercial (0 to 70°C); Industrial (-40 to +85°C); and Extended Industrial/Military (-55 to +125°C).

The CD54AC/ACT161 and CD54AC/ACT163, available in chip form (H suffix), are operable over the -55 to +125°C temperature range.

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*
- *± 24-mA output drive current*
  - *Fanout to 15 FAST* ICs*
  - *Drives 50-ohm transmission lines*

*FAST is a Registered Trademark of Fairchild Semiconductor Corp.



TERMINAL ASSIGNMENT

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File Number **1959**

CD54/74AC161, CD54/74AC163
CD54/74ACT161, CD54/74ACT163

MODE SELECT — FUNCTION TABLE (AC/ACT161)

OPERATING MODE	INPUTS						OUTPUTS	
	$\overline{MR}$	CP	PE	TE	$\overline{SPE}$	P_n	Q_n	TC
Reset (Clear)	L	X	X	X	X	X	L	L
Parallel Load	H	⎍	X	X	l	l	L	L
	H	⎍	X	X	l	h	H	(a)
Count	H	⎍	h	h	h	x	count	(a)
Inhibit	H	X	l	X	h	X	q_n	(a)
	H	X	X	l	h	X	q_n	L

MODE SELECT — FUNCTION TABLE (AC/ACT163)

OPERATING MODE	INPUTS						OUTPUTS	
	$\overline{MR}$	CP	PE	TE	$\overline{SPE}$	P_n	Q_n	TC
Reset (Clear)	l	⎍	X	X	X	X	L	L
Parallel Load	h	⎍	X	X	l	l	L	L
	h	⎍	X	X	l	h	H	(a)
Count	h	⎍	h	h	h	X	count	(a)
Inhibit	h	X	l	X	h	X	q_n	(a)
	h	X	X	l	h	X	q_n	L

H = HIGH voltage level steady state.
L = LOW voltage level steady state.
h = HIGH voltage level one setup time prior to the LOW-to-HIGH clock transition.
l = LOW voltage level one setup time prior to the LOW-to-HIGH clock transition.
X = Don't care.
q = Lowercase letters indicate the state of the referenced output prior to the LOW-to-HIGH clock transition.
⎍ = LOW-to-HIGH clock transition.

NOTE:
(a) The TC output is HIGH when TE is HIGH and the counter is at Terminal Count (HHHH).

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°C (PACKAGE TYPE E) ..... 500 mW
For T_A = +100 to +125°C (PACKAGE TYPE E) ..... Derate Linearly at 8 mW/°C to 300 mW
For T_A = -55 to +70°C (PACKAGE TYPE M) ..... 400 mW
For T_A = +70 to +125°C (PACKAGE TYPE M) ..... Derate Linearly at 6 mW/°C to 70 mW
OPERATING-TEMPERATURE RANGE (T_A) ..... -55 to +125°C
STORAGE TEMPERATURE (T_{stg}) ..... -65 to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance 1/16 ± 1/32 in. (1.59 ± 0.79 mm) from case for 10 s maximum ..... +265°C
Unit inserted into PC board min. thickness 1/16 in. (1.59 mm) with solder contacting lead tips only ..... +300°C

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

CD54/74AC161, CD54/74AC163
CD54/74ACT161, CD54/74ACT163

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

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

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

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	—	0.1	V
		0.05	3	—	0.1	—	0.1	—	0.1	
		0.05	4.5	—	0.1	—	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
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.

CD54/74AC161, CD54/74AC163
CD54/74ACT161, CD54/74ACT163

STATIC ELECTRICAL CHARACTERISTICS: ACT 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}			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
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 LOAD*
Pn	0.13
CP	1
$\overline{MR}$, TE	0.83
$\overline{SPE}$	0.67
PE	0.5

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

CD54/74AC161, CD54/74AC163
CD54/74ACT161, CD54/74ACT163

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.	
Max. CP Frequency	f_{max}	1.5	8	—	7	—	MHz
		3.3*	73	—	64	—	
		5†	103	—	90	—	
CP Pulse Width $\overline{SPE}$ HIGH (Count)	t_w	1.5	61	—	69	—	ns
		3.3	6.8	—	7.7	—	
		5	4.8	—	5.5	—	
$\overline{SPE}$ LOW (Load)	t_w	1.5	61	—	69	—	ns
		3.3	6.8	—	7.7	—	
		5	4.8	—	5.5	—	
$\overline{MR}$ Pulse Width (161)	t_w	1.5	55	—	63	—	ns
		3.3	6.1	—	7	—	
		5	4.4	—	5	—	
Setup Time Pn to CP	t_{su}	1.5	55	—	63	—	ns
		3.3	6.1	—	7	—	
		5	4.4	—	5	—	
PE or TE to CP	t_{su}	1.5	55	—	63	—	ns
		3.3	6.1	—	7	—	
		5	4.4	—	5	—	
$\overline{SPE}$ or $\overline{MR}$ to CP (163)	t_{su}	1.5	66	—	75	—	ns
		3.3	7.4	—	8.4	—	
		5	5.3	—	6	—	
Hold Time Pn to CP	t_H	1.5	0	—	0	—	ns
		3.3	0	—	0	—	
		5	0	—	0	—	
PE or TE to CP	t_H	1.5	0	—	0	—	ns
		3.3	0	—	0	—	
		5	0	—	0	—	
$\overline{SPE}$ or $\overline{MR}$ to CP (163)	t_H	1.5	0	—	0	—	ns
		3.3	0	—	0	—	
		5	0	—	0	—	
Recovery Time $\overline{MR}$ to CP (161)	t_{REC}	1.5	66	—	75	—	ns
		3.3	7.4	—	8.4	—	
		5	5.3	—	6	—	

*3.3 V: min. is @ 3 V
†5 V: min is @ 4.5 V

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CD54/74AC161, CD54/74AC163
CD54/74ACT161, CD54/74ACT163

SWITCHING CHARACTERISTICS: AC Series; t_r, t_f = 3 ns, C_L = 50 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 Qn ($\overline{SPE}$ HIGH)	t_{PLH}	1.5	—	188	—	207	ns
	t_{PHL}	3.3*	5.9	21	5.8	23.1	
		5†	4.2	15	4.1	16.5	
CP to Qn ($\overline{SPE}$ LOW)	t_{PLH}	1.5	—	188	—	207	ns
	t_{PHL}	3.3	5.9	21	5.8	23.1	
		5	4.2	15	4.1	16.5	
CP to TC	t_{PLH}	1.5	—	190	—	209	ns
	t_{PHL}	3.3	6	21	5.9	23.4	
		5	4.3	15.2	4.2	16.7	
TE to TC	t_{PLH}	1.5	—	117	—	129	ns
	t_{PHL}	3.3	3.7	13.1	3.6	14.4	
		5	2.7	9.4	2.6	10.3	
$\overline{MR}$ to Qn (161)	t_{PLH}	1.5	—	188	—	207	ns
	t_{PHL}	3.3	5.9	21	5.8	23.1	
		5	4.2	15	4.1	16.5	
$\overline{MR}$ to TC (161)	t_{PLH}	1.5	—	188	—	207	ns
	t_{PHL}	3.3	5.9	21	5.8	23.1	
		5	4.2	15	4.1	16.5	
Power Dissipation Capacitance	C_{PD}§	—	66 Typ.		66 Typ.		pF
Input Capacitance	C_I	—	—	10	—	10	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 flip-flop.

$P_D = C_{PD}V_{CC}^2 f_i + \Sigma (C_L V_{CC}^2 f_o)$ 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.	
Max. CP Frequency	f_{max}	5*	91	—	80	—	MHz
CP Pulse Width $\overline{SPE}$ HIGH (Count)	t_W	5	5.4	—	6.2	—	ns
$\overline{SPE}$ LOW (Load)	t_W	5	5.4	—	6.2	—	ns
$\overline{MR}$ Pulse Width (161)	t_W	5	5.3	—	6	—	ns
Setup Time Pn to CP	t_{SU}	5	4.4	—	5	—	ns
PE or TE to CP		5	5.3	—	6	—	
$\overline{SPE}$ or $\overline{MR}$ to CP (163)		5	6.6	—	7.5	—	
Hold Time Pn to CP	t_H	5	0	—	0	—	ns
PE or TE to CP		5	0	—	0	—	
$\overline{SPE}$ or $\overline{MR}$ to CP (163)		5	0	—	0	—	
Recovery Time $\overline{MR}$ to CP (161)	t_{REC}	5	5.3	—	6	—	ns

*5 V: min. is @ 4.5 V

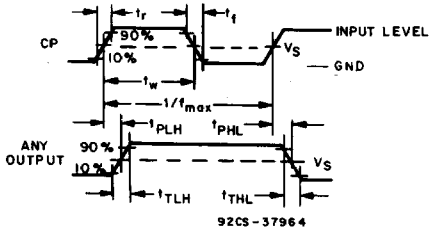
SWITCHING CHARACTERISTICS: ACT Series; t_r, t_f = 3 ns, C_L = 50 pF

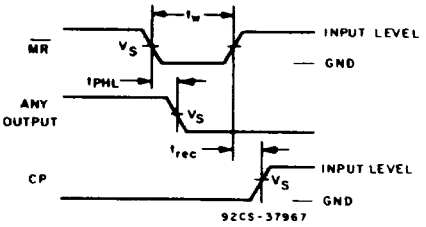
CHARACTERISTICS	SYMBOL	V_{CC} (V)	AMBIENT TEMPERATURE (T_A) - °C				UNITS
			-40 to +85		-55 to +125		
			MIN.	MAX.	MIN.	MAX.	
Propagation Delays: CP to Qn ($\overline{SPE}$ HIGH)	t_{PLH} t_{PHL}	5*	4.2	15	4.1	16.5	ns
CP to Qn ($\overline{SPE}$ LOW)		5	4.2	15	4.1	16.5	ns
CP to TC		5	4.3	15.2	4.2	16.7	ns
TE to TC		5	2.8	9.8	2.7	10.8	ns
$\overline{MR}$ to Qn (161)		5	4.2	15	4.1	16.5	ns
$\overline{MR}$ to TC (161)		5	4.2	15	4.1	16.5	ns
Power Dissipation Capacitance	C_{PD}§	—	66 Typ.		66 Typ.		pF
Input Capacitance	C_I	—	—	10	—	10	pF

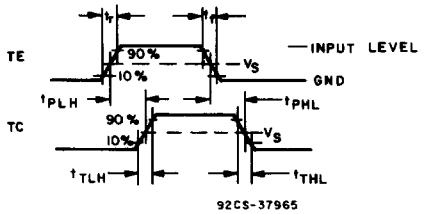
*5 V: min. is @ 5.5 V
max. is @ 4.5 V

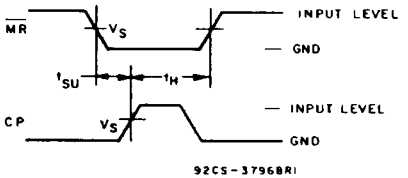
§C_{PD} is used to determine the dynamic power consumption, per flip-flop.
$P_D = C_{PD}V_{CC}^2 f_i + \Sigma (C_L V_{CC}^2 f_o) + V_{CC}\Delta I_{CC}$ where f_i = input frequency
f_o = output frequency
C_L = output load capacitance
V_{CC} = supply voltage.

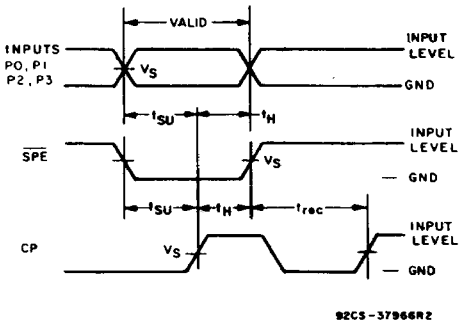
CD54/74AC161, CD54/74AC163
CD54/74ACT161, CD54/74ACT163

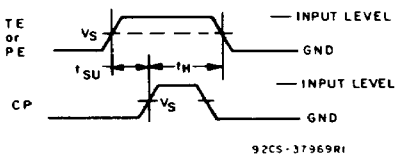


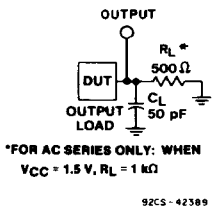












	CD54/74AC	CD54/74ACT
Input Level	V_{CC}	3 V
Input Switching Voltage, V_S	0.5 V_{CC}	1.5 V
Output Switching Voltage, V_S	0.5 V_{CC}	0.5 V_{CC}

Fig. 1 - Propagation delay times, setup, hold, and recovery times, and test circuit.

CD54/74AC161, CD54/74AC163
CD54/74ACT161, CD54/74ACT163

Sequence illustrated in waveforms
1. **Reset outputs to zero.**
2. **Preset to binary twelve.**
3. **Count to thirteen, fourteen, fifteen, zero, one, and two.**
4. **Inhibit.**

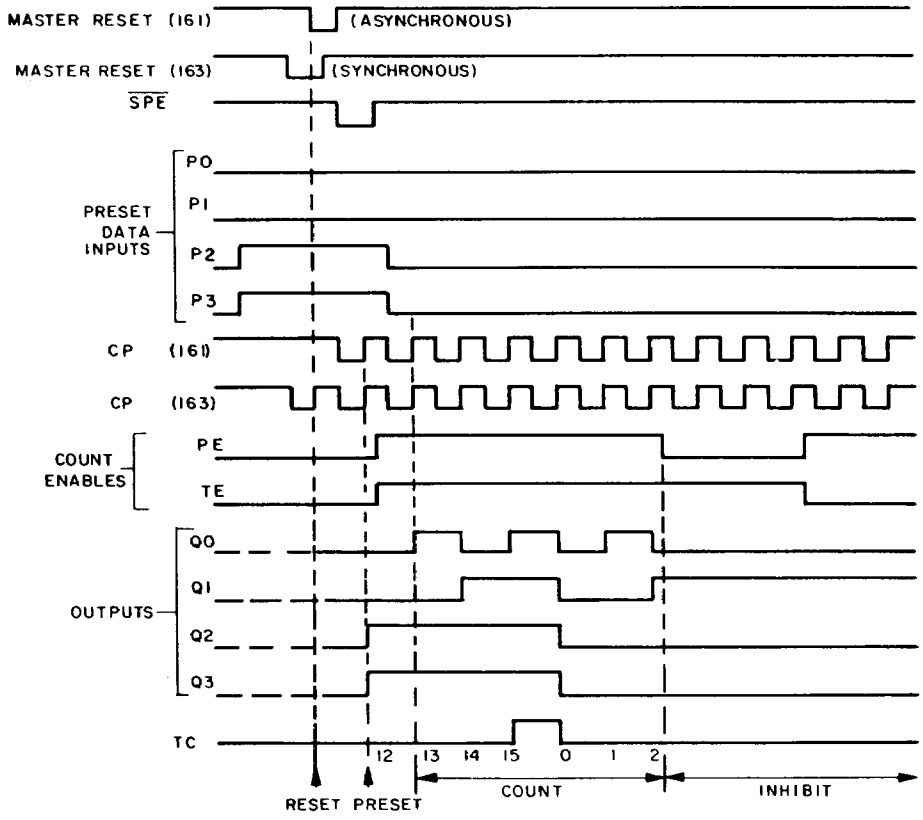


Fig. 2 - Timing diagrams for the CD54/74AC/ACT 161 and 163.