

SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

TC74HC160P DECADE, ASYNCHRONOUS CLEAR
TC74HC161P BINARY, ASYNCHRONOUS CLEAR
TC74HC162P DECADE, SYNCHRONOUS CLEAR
TC74HC163P BINARY, SYNCHRONOUS CLEAR

The TC74HC160, 161, 162 and 163 are high speed CMOS SYNCHRONOUS PRESETTABLE COUNTERS fabricated with silicon gate C²MOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The TC74HC160/162 are BCD decode counters and the TC74HC161/163 are 4 bit binary counters.

The CLOCK input is active on the rising edge. Both $\overline{\text{LOAD}}$ and $\overline{\text{CLEAR}}$ inputs are active on "L" level.

Presetting of all four IC's is synchronous to the rising edge of CLOCK.

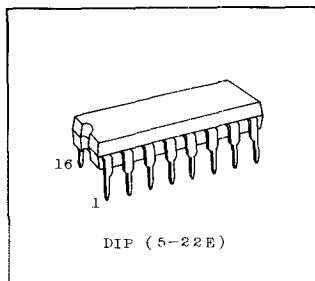
Clear function on the TC74HC162/163 is synchronous to CLOCK, while the TC74HC160/161 counters are cleared asynchronously.

Two enable inputs (TE and PE) and CARRY output are provided to enable easy cascading of counters, which facilitates easy implementation of N-bit counters without using external gate.

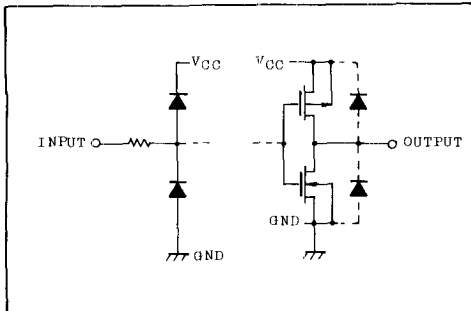
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

FEATURES:

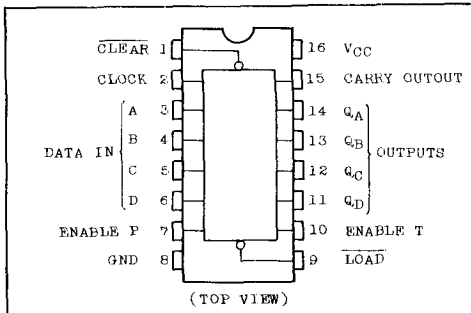
- High Speed..... $f_{\text{MAX}}=50\text{MHz(Typ.)}$ at $V_{\text{CC}}=5\text{V}$
- Low Power Dissipation..... $I_{\text{CC}}=4\mu\text{A(Max.)}$ at $T_a=25^\circ\text{C}$
- High Noise Immunity..... $V_{\text{NIH}}=V_{\text{NIL}}=28\% V_{\text{CC(Min.)}}$
- Output Drive Capability.....10 LSTTL Loads
- Symmetrical Output Impedance... $|I_{\text{OH}}|=I_{\text{OL}}=4\text{mA(Min.)}$
- Balanced Propagation Delays... $t_{\text{pLH}} \doteq t_{\text{pHL}}$
- Wide Operating Voltage Range... $V_{\text{CC(opr)}}=2\text{V} \sim 6\text{V}$
- Pin and Function Compatible with 74LS160 ~163.



INPUT and OUTPUT EQUIVALENT CIRCUIT



PIN ASSIGNMENT



TRUTH TABLE

TC74HC160/161					TC74HC162/163					OUTPUTS				FUNCTION
INPUTS					INPUTS					QAQBQCQD				
CLR	LD	PE	TE	CK	CLR	LD	PE	TE	CK					
L	*	*	*	*	L	*	*	*		L	L	L	L	RESET TO "0"
H	L	*	*		H	L	*	*		A	B	C	D	PRESET DATA
H	H	*	L		H	H	*	L		NO CHANGE				NO COUNT
H	H	L	*		H	H	L	*		NO CHANGE				NO COUNT
H	H	H	H		H	H	H	H		COUNT UP				COUNT
H	*	*	*		*	*	*	*		NO CHANGE				NO COUNT

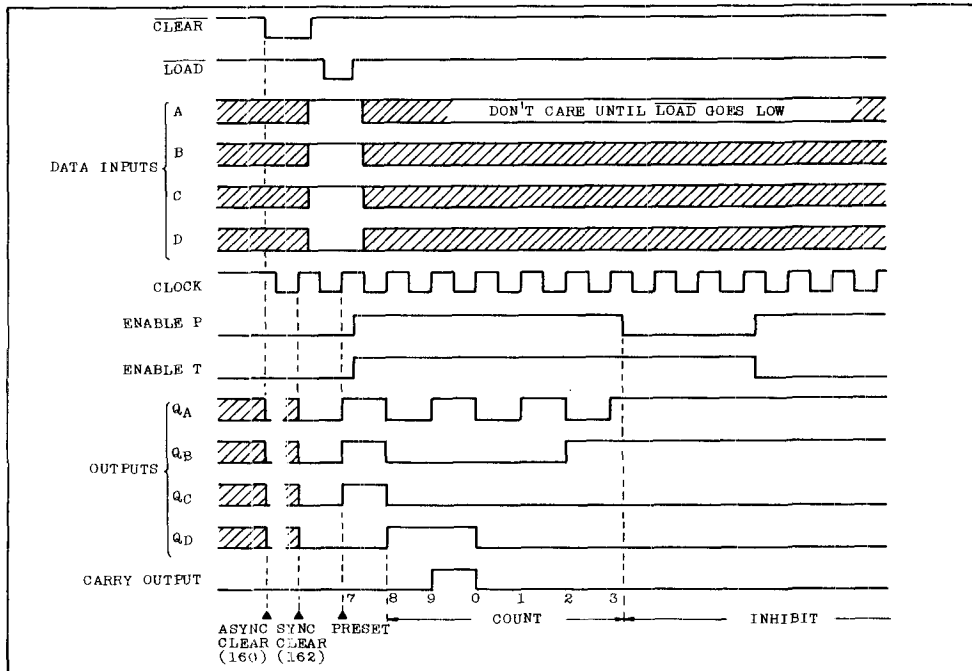
Note * : Don't Care

A, B, C, D : Logic level of data inputs

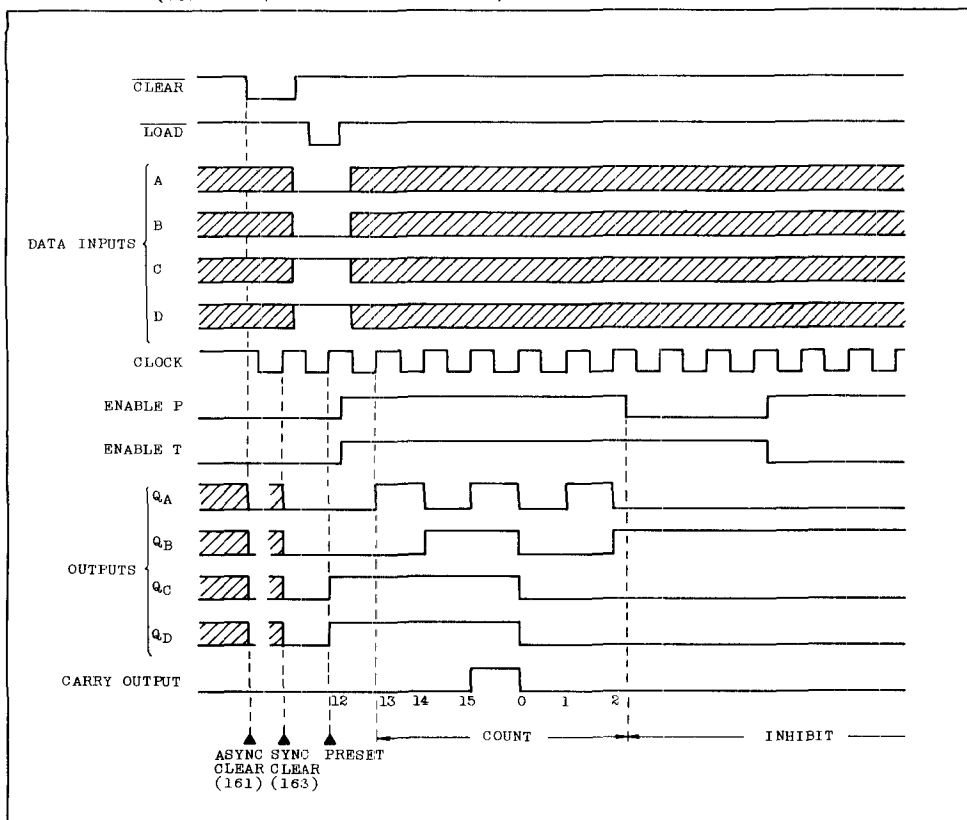
Carry : $CARRY = TE \cdot Q_A \cdot \bar{Q}_B \cdot \bar{Q}_C \cdot Q_D$ (TC74HC160/162)

$CARRY = TE \cdot Q_A \cdot Q_B \cdot Q_C \cdot Q_D$ (TC74HC161/163)

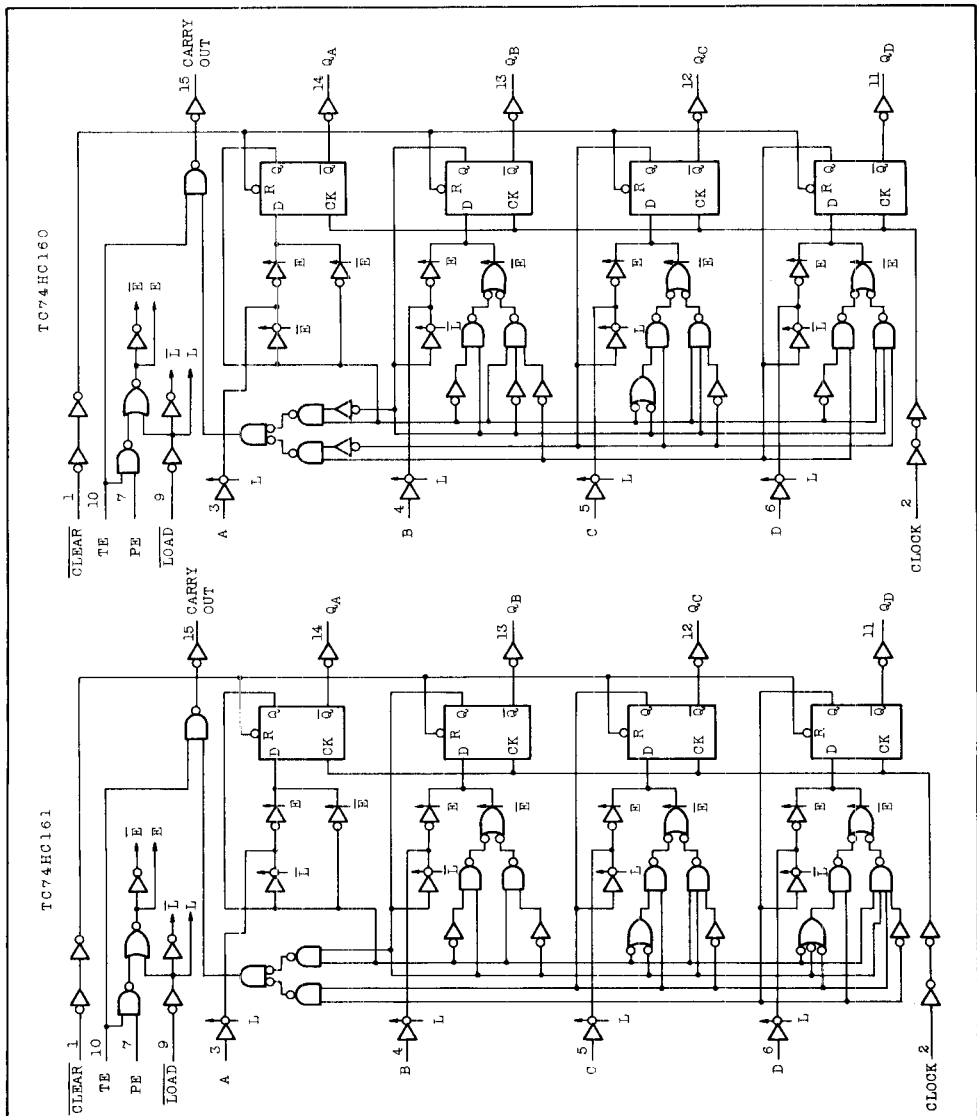
TIMING CHART (TC74HC160/162 : DECADE COUNTER)



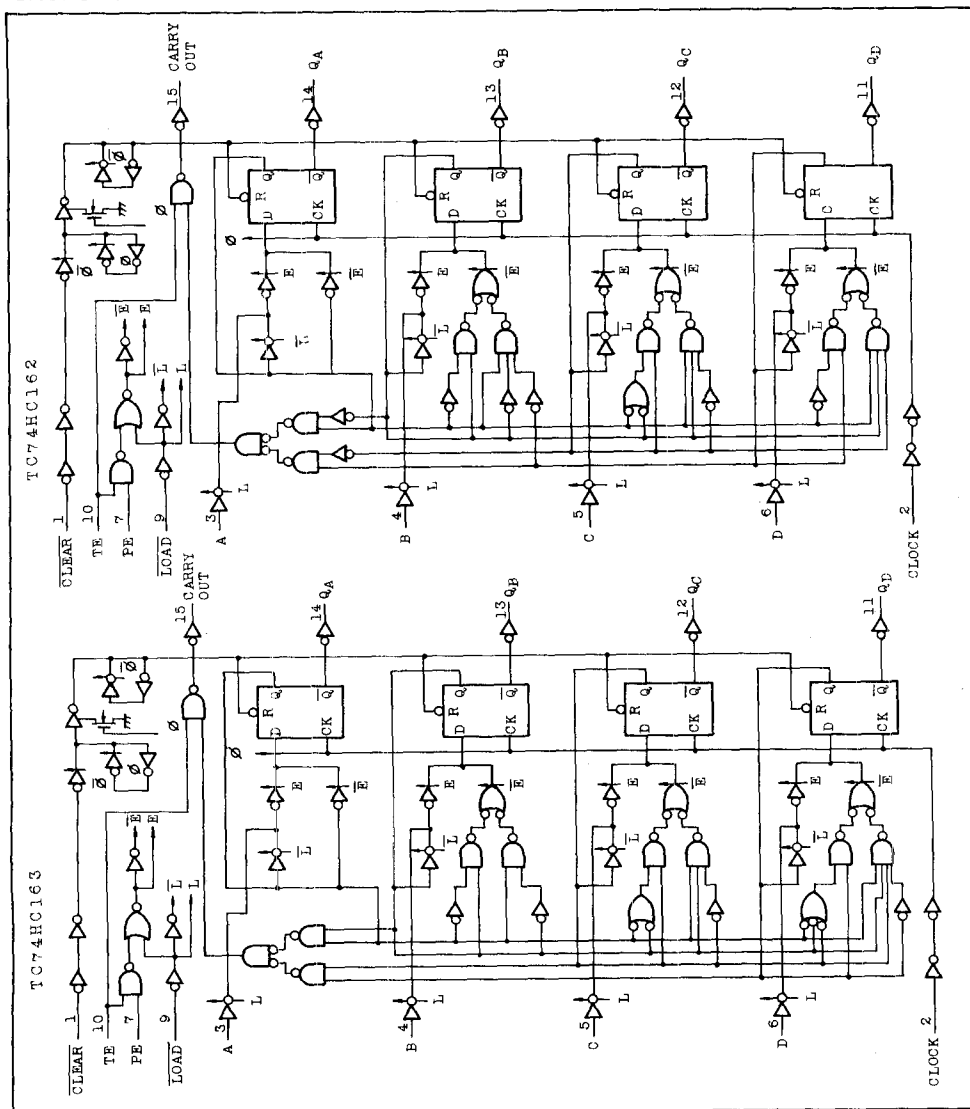
TIMING CHART (TC74HC161/163 : BINARY COUNTER)



LOGIC DIAGRAM

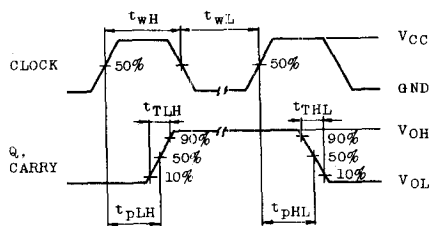


LOGIC DIAGRAM

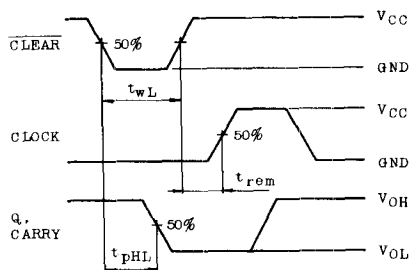


SWITCHING CHARACTERISTICS TEST WAVEFORM

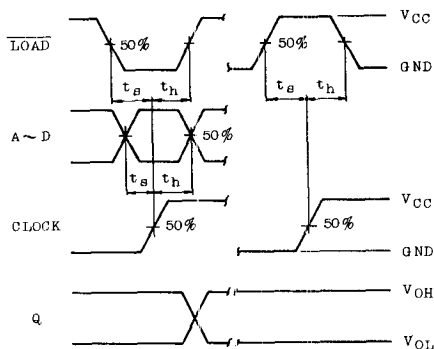
COUNT MODE



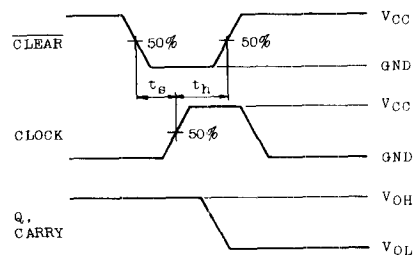
CLEAR MODE (TC74HC160P/161P)



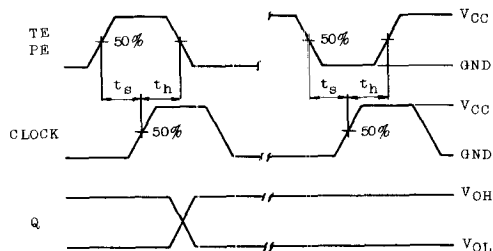
PRESET MODE



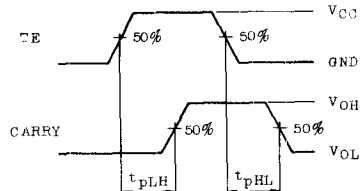
CLEAR MODE (TC74HC162P/163P)



COUNT ENABLE MODE



CASCADE MODE
(Fix Maximum Count)



DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION		Ta=25°C			Ta=-40~85°C		UNIT
				V _{CC}	MIN.	TYP.	MAX.	MIN.	
Low-Level Output Voltage	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} =20μA	2.0	-	0.0	0.1	-	V
				4.5	-	0.0	0.1	-	
				6.0	-	0.0	0.1	-	
			I _{OL} =4mA	4.5	-	0.17	0.32	-	
			I _{OL} =5.2mA	6.0	-	0.18	0.32	-	
Input Leakage Current	I _{IN}	V _{IN} =V _{CC} or GND		6.0	-	-	±0.1	-	μA
Quiescent Supply Current	I _{CC}	V _{IN} =V _{CC} or GND		6.0	-	-	4.0	-	

AC ELECTRICAL CHARACTERISTICS (C_L=50pF, Input t_r=t_f=6ns)

PARAMETER	SYMBOL	TEST CONDITION	V _{CC}	Ta=25°C			Ta=-40~85°C		UNIT
				MIN.	TYP.	MAX.	MIN.	MAX.	
Output Transition Time	t _{TLH} t _{THL}		2.0	-	30	75	-	90	ns
			4.5	-	8	15	-	18	
			6.0	-	7	13	-	16	
Propagation Delay Time CLOCK - Q	t _{pLH} t _{pHL}		2.0	-	75	165	-	200	
			4.5	-	22	33	-	40	
			6.0	-	19	28	-	34	
	CLOCK - CARRY		2.0	-	95	200	-	240	
			4.5	-	26	40	-	48	
			6.0	-	22	34	-	41	
TE - CARRY	t _{pLH} t _{pHL}		2.0	-	40	100	-	120	
			4.5	-	13	20	-	24	
			6.0	-	11	17	-	21	
	CLEAR - Q*		2.0	-	90	185	-	225	
			4.5	-	24	37	-	45	
			6.0	-	21	32	-	39	
CLEAR - CARRY*	t _{pHL}		2.0	-	105	210	-	260	
			4.5	-	28	42	-	51	
			6.0	-	24	36	-	44	
Maximum Clock Frequency	f _{MAX}		2.0	5	9	-	4	-	MHz
			4.5	25	45	-	20	-	
			6.0	29	53	-	23	-	

AC ELECTRICAL CHARACTERISTICS ($C_L=50\text{pF}$, Input $t_r=t_f=6\text{ns}$)

PARAMETER	SYMBOL	TEST CONDITION	$T_a=25^\circ\text{C}$			$T_a=-40\sim 85^\circ\text{C}$			UNIT
			V_{CC}	MIN.	TYP.	MAX.	MIN.	MAX.	
Minimum Pulse Width CLOCK	$t_{w(L)}$ $t_{w(H)}$		2.0	-	30	75	-	90	ns
			4.5	-	8	15	-	18	
			6.0	-	7	13	-	16	
$\overline{\text{CLEAR}}^*$	$t_{w(L)}$		2.0	-	30	75	-	90	
			4.5	-	8	15	-	18	
			6.0	-	7	13	-	16	
Minimum Set-up Time $\overline{\text{LOAD}}$, PE, TE	t_s		2.0	-	50	125	-	150	
			4.5	-	14	25	-	30	
			6.0	-	12	22	-	27	
A, B, C, D	t_s		2.0	-	35	75	-	90	
			4.5	-	8	15	-	18	
			6.0	-	7	13	-	16	
$\overline{\text{CLEAR}}^{**}$	t_s		2.0	-	35	75	-	90	
			4.5	-	8	15	-	18	
			6.0	-	7	13	-	16	
Minimum Hold Time	t_h		2.0	-	-	0	-	0	
			4.5	-	-	0	-	0	
			6.0	-	-	0	-	0	
Minimum Removal Time $\overline{\text{CLEAR}}^*$	t_{rem}		2.0	-	-	75	-	90	
			4.5	-	-	15	-	18	
			6.0	-	-	13	-	16	
Input Capacitance	C_{IN}			-	5	7.5	-	7.5	pF
Power Dissipation Capacitance	$C_{PD(1)}$			-	57	-	-	-	

Note (1) C_{PD} is defined as the value of internal equivalent capacitance of IC which is calculated from the operating current consumption without load (refer to Test Circuit).

Average operating current can be obtained by the equation hereunder.

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

(2) * for TC74HC160/161 only

** for TC74HC162/163 only

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V _{CC}	-0.5 ~ 7	V
DC Input Voltage	V _{IN}	-0.5 ~ V _{CC} +0.5	V
DC Output Voltage	V _{OUT}	-0.5 ~ V _{CC} +0.5	V
Input Diode Current	I _{IK}	±20	mA
Output Diode Current	I _{OK}	±20	mA
DC Output Current	I _{OUT}	±25	mA
DC V _{CC} /Ground Current	I _{CC}	±50	mA
Power Dissipation	P _D	500*	mW
Storage Temperature	T _{stg}	-65 ~ 150	°C
Lead Temperature 10sec	T _L	300	°C

* 500mW in the range of
Ta=-40°C ~ 65°C.
and from Ta=65°C up to
85°C derating factor
of -10mW/°C shall be
applied until 300mW.

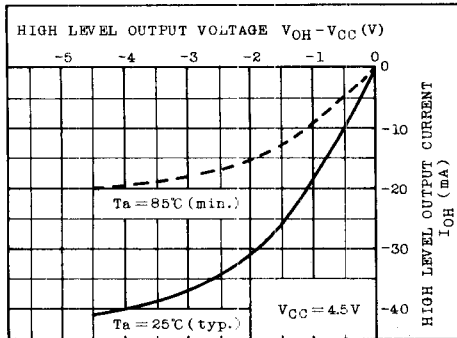
RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	LIMIT	UNIT
Supply Voltage	V _{CC}	2 ~ 6	V
Input Voltage	V _{IN}	0 ~ V _{CC}	V
Output Voltage	V _{OUT}	0 ~ V _{CC}	V
Operating Temperature	T _{opr}	-40 ~ 85	°C
Input Rise and Fall Time	t _r , t _f	0 ~ 500	ns

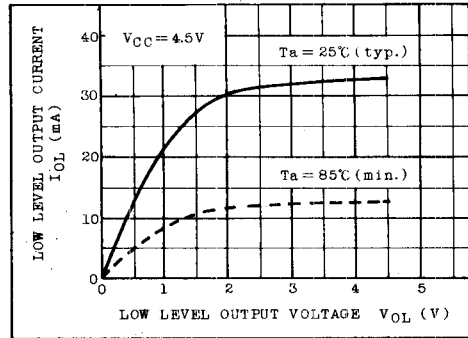
DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION		Ta=25°C				Ta=-40~85°C		UNIT
				V _{CC}	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Input Voltage	V _{IH}			2.0	1.5	-	-	1.5	-	V
				4.5	3.15	-	-	3.15	-	
				6.0	4.2	-	-	4.2	-	
Low-Level Input Voltage	V _{IL}			2.0	-	-	0.5	-	0.5	V
				4.5	-	-	1.35	-	1.35	
				6.0	-	-	1.8	-	1.8	
High-Level Output Voltage	V _{OH}	V _{IN} =	I _{OH} =-20μA	2.0	1.9	2.0	-	1.9	-	V
				4.5	4.4	4.5	-	4.4	-	
		V _{IH} or V _{IL}	I _{OH} =-4mA	4.5	4.18	4.31	-	4.13	-	
			I _{OH} =-5.2mA	6.0	5.68	5.80	-	5.63	-	

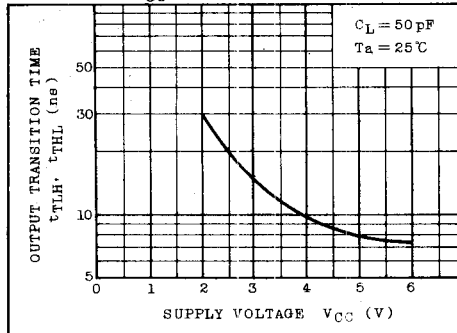
I_{OH} CHARACTERISTICS



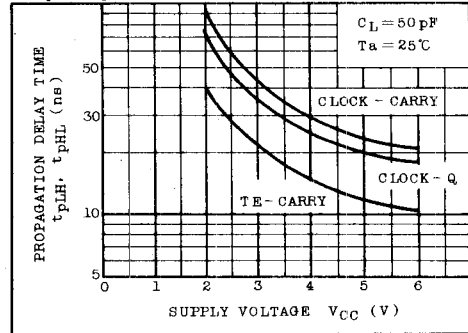
I_{OL} CHARACTERISTICS



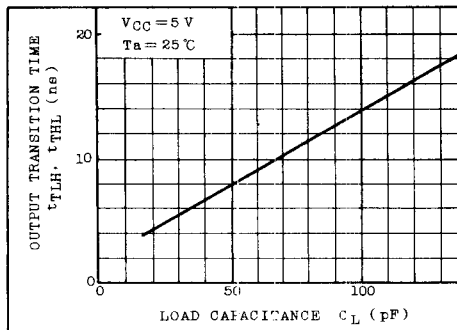
$t_{TLH}, t_{THL} - V_{CC}$ CHARACTERISTICS (TYP.)



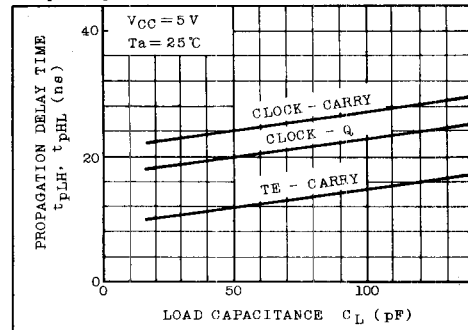
$t_{PLH}, t_{PHL} - V_{CC}$ CHARACTERISTICS (TYP.)



$t_{TLH}, t_{THL} - C_L$ CHARACTERISTICS (TYP.)

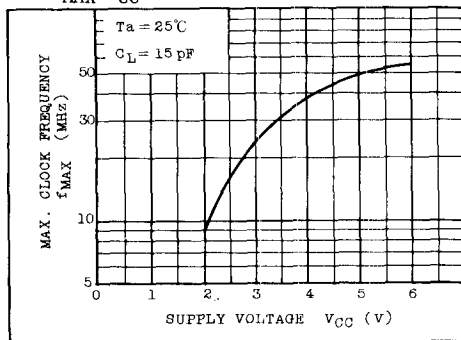


$t_{PLH}, t_{PHL} - C_L$ CHARACTERISTICS (TYP.)

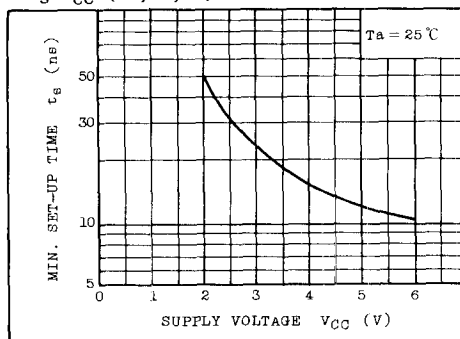


TC74HC160P • TC74HC161P
TC74HC162P • TC74HC163P

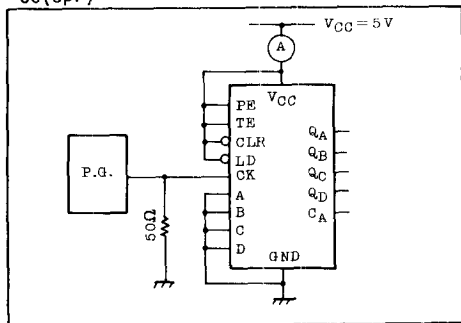
f_{MAX} - V_{CC} CHARACTERISTICS (TYP.)



t_s - V_{CC} ($\overline{LD}$, TE, PE) CHARACTERISTICS (TYP.)



$I_{CC(opr)}$ TEST CIRCUIT



OPERATING CURRENT CONSUMPTION WITH LOAD CAPACITANCE

When the outputs drive capacitive load, total current consumption is to be a sum of the value calculated from C_{PD} and ΔI_{CC} obtained from the following formula.

In case of TC74HC160/162

$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \left(\frac{C_a}{2} + \frac{C_b}{5} + \frac{C_c}{10} + \frac{C_d}{10} + \frac{C_{ca}}{10} \right)$$

In case of TC74HC161/163

$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \left(\frac{C_a}{2} + \frac{C_b}{4} + \frac{C_c}{8} + \frac{C_d}{16} + \frac{C_{ca}}{16} \right)$$

$C_a \sim C_{ca}$ are the capacitance at QA ~ CARRY output.

TYPICAL APPLICATION

