

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC74HC161AP, TC74HC161AF, TC74HC161AFN TC74HC163AP, TC74HC163AF, TC74HC163AFN

SYNCHRONOUS PRESETTABLE 4 – BIT COUNTER

TC74HC161AP/AF/AFN BINARY, ASYNCHRONOUS CLEAR
TC74HC163AP/AF/AFN BINARY, SYNCHRONOUS CLEAR

(Note) The JEDEC SOP (FN) is not available in Japan.

The TC74HC161A and 163A are high speed CMOS BINARY PRESETTABLE COUNTERS fabricated with silicon gate C²MOS technology.

They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation. The CK input is active on the rising edge. Both $\overline{\text{LOAD}}$ and $\overline{\text{CLR}}$ inputs are active on low logic level.

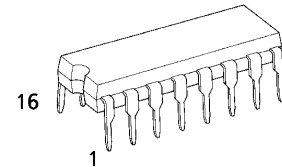
Presetting of all four IC's is synchronous to the rising edge of CK.

The clear function of the TC74HC163A is synchronous to CK, while the TC74HC161A is cleared asynchronously.

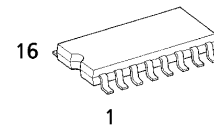
Two enable inputs (ENP and ENT) and CO are provided to enable easy cascading of counters, which facilitates easy implementation of n-bit counters without using external gates. All inputs are equipped with protection circuits against static discharge or transient excess voltage.

FEATURES:

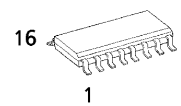
- High Speed..... $f_{\text{MAX}} = 63\text{MHz}(\text{typ.})$ at $V_{\text{CC}} = 5\text{V}$
- Low Power Dissipation..... $I_{\text{CC}} = 4\mu\text{A}(\text{Max.})$ at $T_a = 25^\circ\text{C}$
- High Noise Immunity..... $V_{\text{NIH}} = V_{\text{NIL}} = 28\% V_{\text{CC}}(\text{Min.})$
- Output Drive Capability..... 10 LSTTL Loads
- Symmetrical Output Impedance... $|I_{\text{OH}}| = I_{\text{OL}} = 4\text{mA}(\text{Min.})$
- Balanced Propagation Delays..... $t_{\text{PLH}} \approx t_{\text{PHL}}$
- Wide Operating Voltage Range... $V_{\text{CC}}(\text{opr.}) = 2\text{V} \sim 6\text{V}$
- Pin and Function Compatible with 74LS161, 163



P (DIP16-P-300-2.54A)
Weight : 1.00g (Typ.)

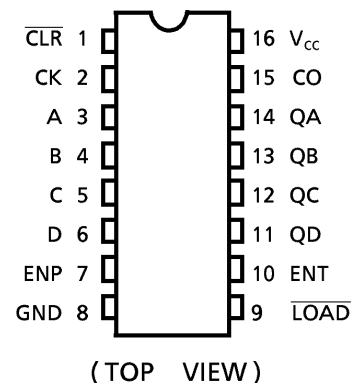


F (SOP16-P-300-1.27)
Weight : 0.18g (Typ.)

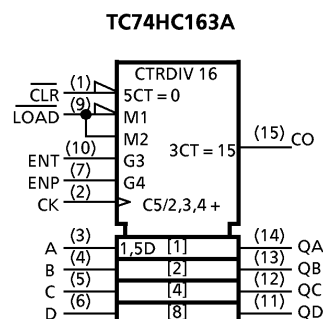
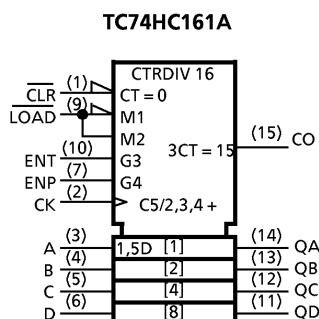


FN (SOL16-P-150-1.27)
Weight : 0.13g (Typ.)

PIN ASSIGNMENT



IEC LOGIC SYMBOL



TRUTH TABLE

TC74HC161A					TC74HC163A					OUTPUTS				FUNCTION
INPUTS					INPUTS									
CLR	LD	ENP	ENT	CK	CLR	LD	ENP	ENT	CK	QA	QB	QC	QD	
L	X	X	X	X	L	X	X	X		L	L	L	L	RESET TO "0"
H	L	X	X		H	L	X	X		A	B	C	D	PRESET DATA
H	H	X	L		H	H	X	L		NO CHANGE				NO COUNT
H	H	L	X		H	H	L	X		NO CHANGE				NO COUNT
H	H	H	H		H	H	H	H		COUNT UP				COUNT
H	X	X	X		X	X	X	X		NO CHANGE				NO COUNT

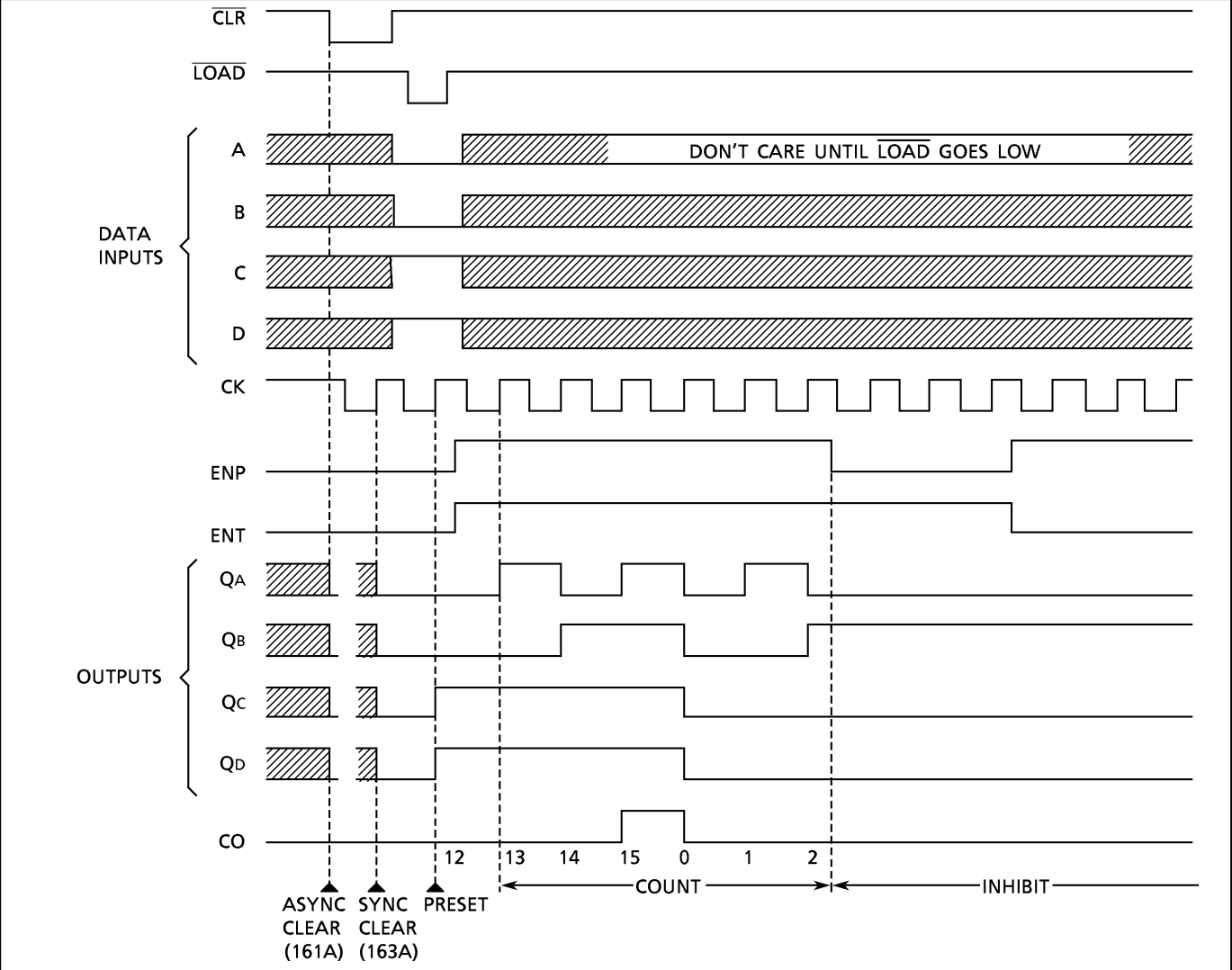
Note

X : Don't Care

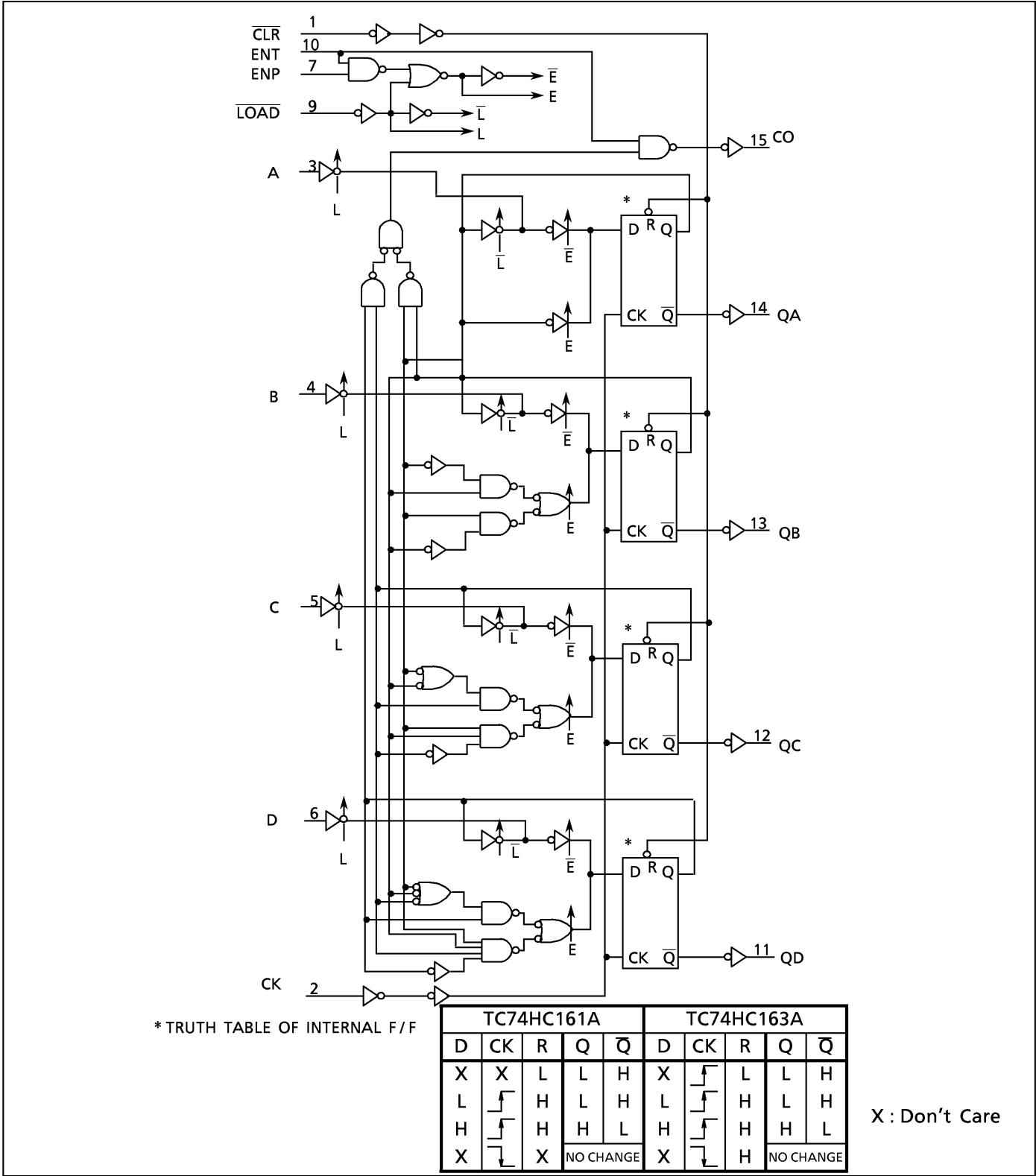
A, B, C, D : Logic Level of Data Inputs

Carry : CARRY = ENT·QA · QB · QC · QD

TIMING CHART



SYSTEM DIAGRAM



ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V_{CC}	$-0.5 \sim 7$	V
DC Input Voltage	V_{IN}	$-0.5 \sim V_{CC} + 0.5$	V
DC Output Voltage	V_{OUT}	$-0.5 \sim V_{CC} + 0.5$	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 (DIP)* / 180 (SOP)	mW
Storage Temperature	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$

*500mW in the range of $T_a = -40^{\circ}\text{C} \sim 65^{\circ}\text{C}$. From $T_a = 65^{\circ}\text{C}$ to 85°C a derating factor of $-10\text{mW}/^{\circ}\text{C}$ shall be applied until 300mW.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	V_{CC}	$2 \sim 6$	V
Input Voltage	V_{IN}	$0 \sim V_{CC}$	V
Output Voltage	V_{OUT}	$0 \sim V_{CC}$	V
Operating Temperature	T_{opr}	$-40 \sim 85$	$^{\circ}\text{C}$
Input Rise and Fall Time	t_r, t_f	$0 \sim 1000 (V_{CC} = 2.0\text{V})$ $0 \sim 500 (V_{CC} = 4.5\text{V})$ $0 \sim 400 (V_{CC} = 6.0\text{V})$	ns

DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION	V_{CC} (V)	$T_a = 25^{\circ}\text{C}$			$T_a = -40 \sim 85^{\circ}\text{C}$		UNIT
				MIN.	TYP.	MAX.	MIN.	MAX.	
High - Level Input Voltage	V_{IH}		2.0 4.5 6.0	1.50 3.15 4.20	— — —	— — —	1.50 3.15 4.20	— — —	V
Low - Level Input Voltage	V_{IL}		2.0 4.5 6.0	— — —	— — —	0.50 1.35 1.80	— — —	0.50 1.35 1.80	V
High - Level Output Voltage	V_{OH}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -20\mu\text{A}$	2.0 4.5 6.0	1.9 4.4 5.9	2.0 4.5 6.0	— — —	1.9 4.4 5.9	V
				4.5 6.0	4.18 5.68	4.31 5.80	— —	4.13 5.63	
Low - Level Output Voltage	V_{OL}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 20\mu\text{A}$	2.0 4.5 6.0	— — —	0.0 0.0 0.1	0.1 0.1 0.1	— — —	V
				4.5 6.0	— —	0.17 0.18	0.26 0.26	— —	
Input Leakage Current	I_{IN}	$V_{IN} = V_{CC} \text{ or } \text{GND}$	6.0	—	—	± 0.1	—	± 1.0	μA
Quiescent Supply Current	I_{CC}	$V_{IN} = V_{CC} \text{ or } \text{GND}$	6.0	—	—	4.0	—	40.0	

TIMING REQUIREMENTS (Input $t_r = t_f = 6\text{ns}$)

PARAMETER	SYMBOL	TEST CONDITION	$V_{CC}(\text{V})$	$T_a = 25^\circ\text{C}$		$T_a = -40\sim 85^\circ\text{C}$	UNIT
				TYP.	LIMIT	LIMIT	
Minimum Pulse Width (CK)	$t_{W(H)}$ $t_{W(L)}$	Fig. 1	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Pulse Width (CLR) *	$t_{W(L)}$	Fig. 4	2.0	—	75	95	
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Set-up Time (LOAD, ENP, ENT)	t_s	Fig. 2, 3	2.0	—	100	125	
			4.5	—	20	25	
			6.0	—	17	21	
Minimum Set-up Time (A, B, C, D)	t_s	Fig. 2	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Set-up Time (CLR) **	t_s	Fig. 5	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Hold Time	t_h	Fig. 2, 3, 5	2.0	—	0	0	ns
			4.5	—	0	0	
			6.0	—	0	0	
Minimum Removal Time (CLR) *	t_{rem}	Fig. 4	2.0	—	50	65	ns
			4.5	—	10	13	
			6.0	—	9	11	
Clock Frequency	f		2.0	—	6	5	MHz
			4.5	—	31	25	
			6.0	—	36	29	

AC ELECTRICAL CHARACTERISTICS ($C_L = 15\text{pF}$, $V_{CC} = 5\text{V}$, $T_a = 25^\circ\text{C}$, Input $t_r = t_f = 6\text{ns}$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t_{TLH} t_{THL}	Fig. 1	—	4	8	ns
Propagation Delay Time (CK—Q)	t_{pLH} t_{pHL}	Fig. 1	—	13	21	
Propagation Delay Time (CK—CO) [Count Mode]	t_{pLH} t_{pHL}	Fig. 1	—	16	26	
Propagation Delay Time (CK—CO) [Preset Mode]	t_{pLH}	Fig. 2	—	18	30	
	t_{pHL}		—	20	35	
Propagation Delay Time (ENT—CO)	t_{pLH} t_{pHL}	Fig. 6	—	10	17	
Propagation Delay Time (CLR—Q) *	t_{pHL}	Fig. 4	—	17	26	
Propagation Delay Time (CLR—CO) *	t_{pHL}	Fig. 4	—	20	35	MHz
Maximum Clock Frequency	f_{MAX}		36	63	—	

*: for TC74HC161A only

**: for TC74HC163A only

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

PARAMETER	SYMBOL	TEST CONDITION	V _{CC} (V)	Ta = 25°C			Ta = -40~85°C		UNIT
				MIN.	TYP.	MAX.	MIN.	MAX.	
Output Transition Time	t _{TLH}		2.0	—	25	75	—	95	ns
	t _{THL}		4.5	—	7	15	—	19	
			6.0	—	6	13	—	16	
Propagation Delay Time (CK—Q)	t _{PLH}	Fig. 1	2.0	—	48	125	—	155	
	t _{PHL}		4.5	—	16	25	—	31	
			6.0	—	14	21	—	26	
Propagation Delay Time (CK—CO) [Count Mode]	t _{PLH}	Fig. 1	2.0	—	57	150	—	190	
	t _{PHL}		4.5	—	19	30	—	38	
			6.0	—	16	26	—	33	
Propagation Delay Time (CK—CO) [Preset Mode]	t _{PLH}	Fig. 2	2.0	—	66	175	—	220	
			4.5	—	22	35	—	44	
			6.0	—	19	30	—	37	
	t _{PHL}		2.0	—	72	200	—	250	
			4.5	—	24	40	—	50	
			6.0	—	20	34	—	43	
Propagation Delay Time (ENT—CO)	t _{PLH}	Fig. 6	2.0	—	39	100	—	125	
	t _{PHL}		4.5	—	13	20	—	25	
			6.0	—	11	17	—	21	
Propagation Delay Time (CLR—Q)*	t _{PHL}	Fig. 4	2.0	—	60	150	—	190	
			4.5	—	20	30	—	38	
			6.0	—	17	26	—	33	
Propagation Delay Time (CLR—CO)*	t _{PHL}	Fig. 4	2.0	—	72	200	—	250	
			4.5	—	24	40	—	50	
			6.0	—	20	34	—	43	
Maximum Clock Frequency	f _{MAX}		2.0	6	18	—	5	—	MHz
			4.5	31	53	—	25	—	
			6.0	36	62	—	29	—	
Input Capacitance	C _{IN}			—	5	10	—	10	pF
Power Dissipation Capacitance	C _{PD} (1)			—	34	—	—	—	

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

Average operating current can be obtained by the equation :

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

When the outputs drive a capacitive load, total current consumption is the sum of C_{PD} , and ΔI_{CC} which is obtained from the following formula :

In case of TC74HC161A / 163A :

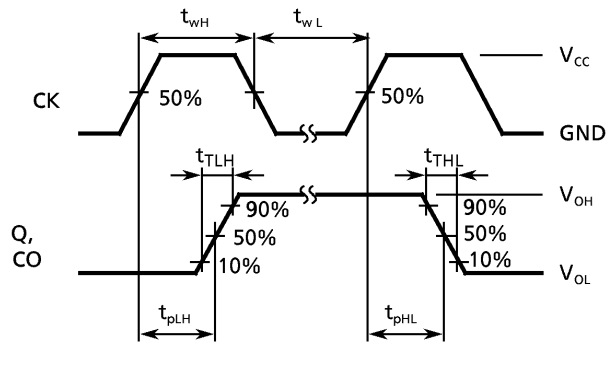
$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \left(\frac{C_{QA}}{2} + \frac{C_{QB}}{4} + \frac{C_{QC}}{8} + \frac{C_{QD}}{16} + \frac{C_{CO}}{16} \right)$$

$C_{QA} \sim C_{QD}$ and C_{CO} are the capacitances at QA~QD and CO, respectively.
 f_{CK} is the input frequency of the CK.

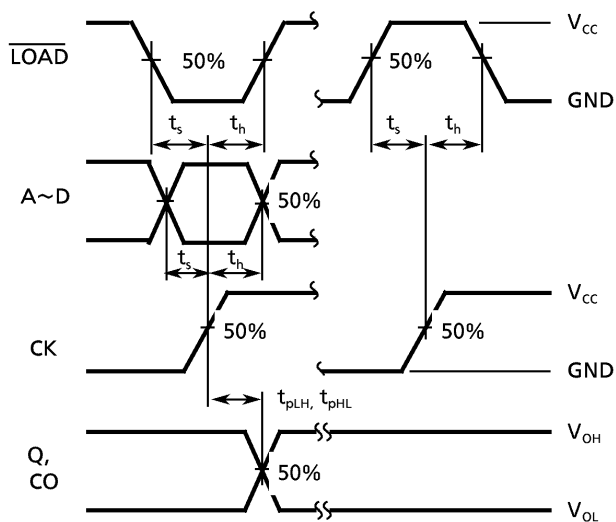
* for TC74HC161A only

SWITCHING CHARACTERISTICS TEST WAVEFORM

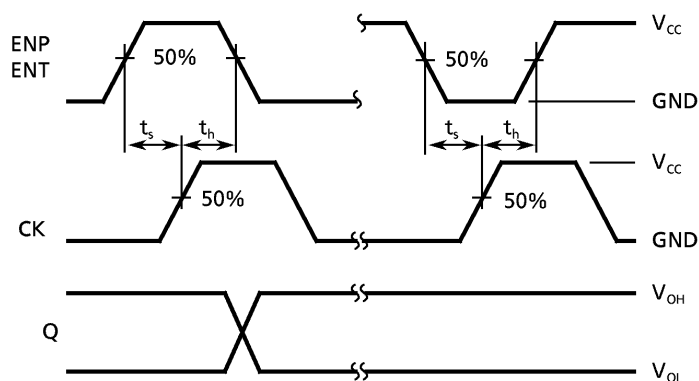
COUNT MODE (Fig. 1)



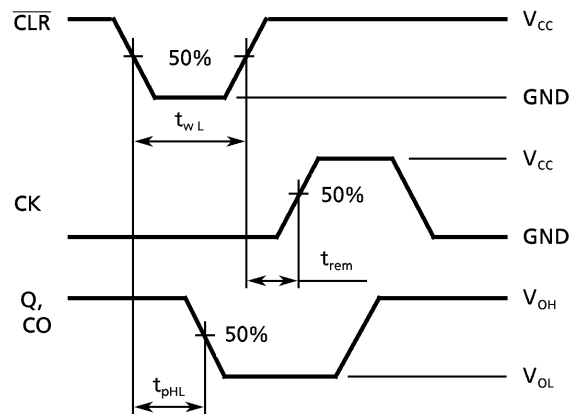
PRESET MODE (Fig. 2)



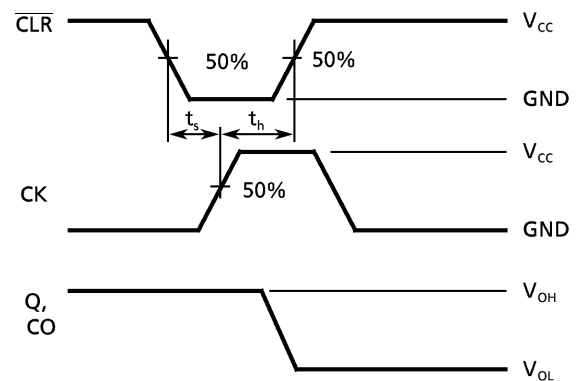
COUNT ENABLE MODE (Fig. 3)



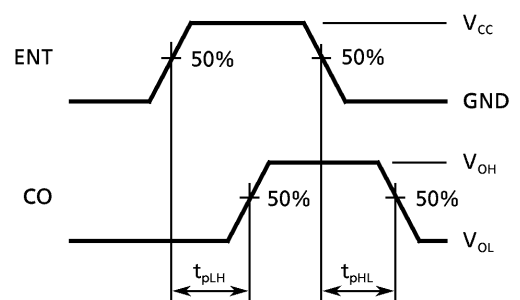
CLEAR MODE (TC74HC161A) (Fig. 4)



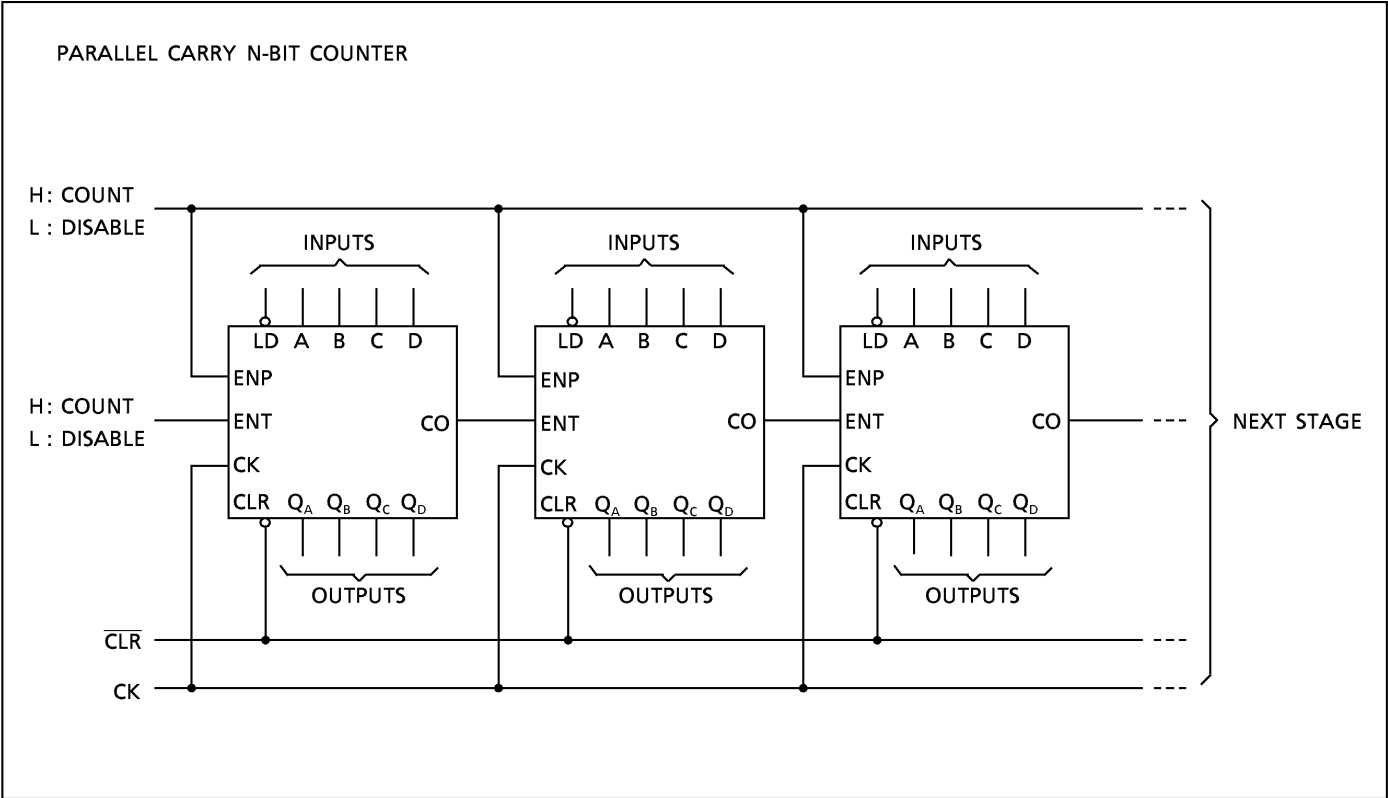
CLEAR MODE (TC74HC163A) (Fig. 5)



CASCADE MODE (Fix Maximum Count) (Fig. 6)

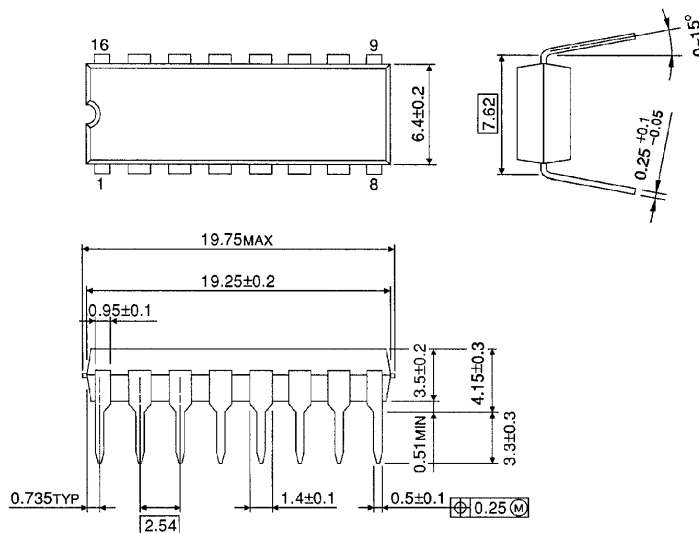


TYPICAL APPLICATION



DIP 16PIN PACKAGE DIMENSIONS (DIP16-P-300-2.54A)

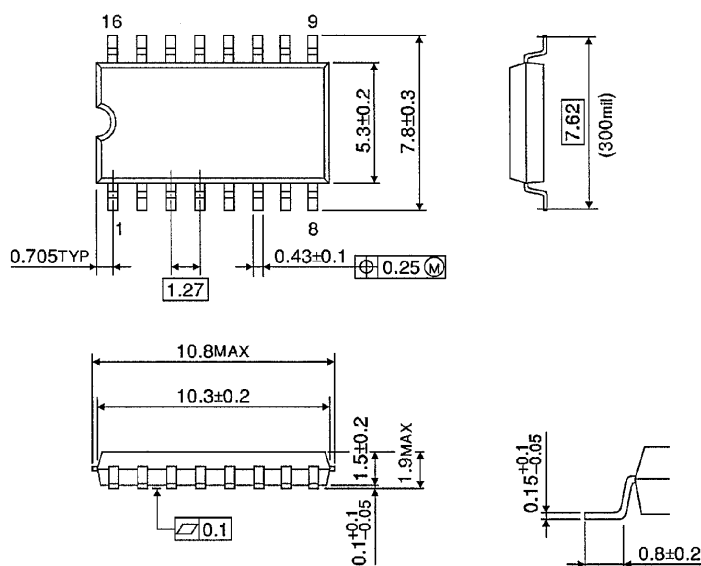
Unit in mm



Weight : 1.00g (Typ.)

SOP 16PIN (200mil BODY) PACKAGE DIMENSIONS (SOP16-P-300-1.27)

Unit in mm

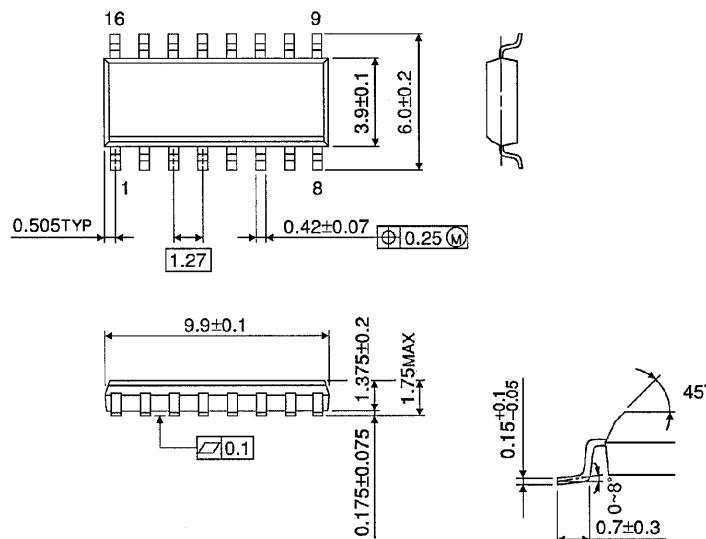


Weight : 0.18g (Typ.)

SOP 16PIN (150mil BODY) PACKAGE DIMENSIONS (SOL16-P-150 -1.27)

Unit in mm

(Note) This package is not available in Japan.



Weight : 0.13g (Typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.