

# HD74LS668 • Synchronous Up/Down Decade Counters

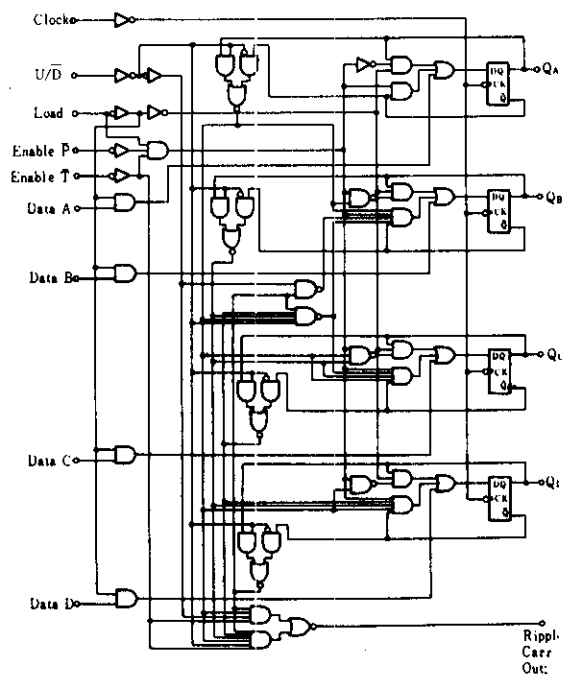
This synchronous presettable decade counter features an internal carry look-ahead for cascading in high-speed counting applications. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation helps eliminate the output counting spikes that are normally associated with asynchronous (ripple-clock) counters.

A buffered clock input triggers the four master-slave flip-flops on the rising (positive-going) edge of the clock waveform. This counter is fully programmable; that is, the outputs may each be preset to either level. The load input circuitry allows loading with the carry-enable output of cascaded counters. As loading is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the data inputs after the next clock pulse.

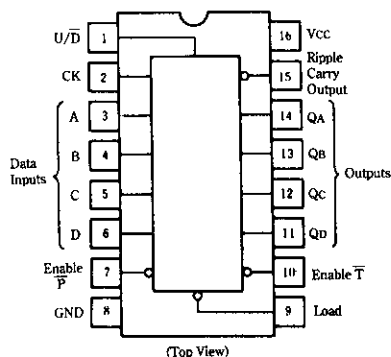
The carry look-ahead circuitry provides for cascading counters for  $n$ -bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count enable inputs and a carry output. Both count enable inputs ( $\bar{P}$

and  $\bar{T}$ ) must be low to count. The direction of the count is determined by the level of the up/down input. When the input is high, the counter counts up; when low, it counts down. Input  $\bar{T}$  is fed forward to enable the carry output. The carry output thus enabled will produce a low-level output pulse with a duration approximately equal to the high portion of the  $Q_A$  output when counting up and approximately equal to the low portion of the  $Q_A$  output when counting down. This low level overflow carry pulse can be used to enable successive cascaded stages. Transitions at the enable  $\bar{P}$  or  $\bar{T}$  inputs are allowed regardless of the level of the clock input. All inputs are diode-clamped to minimize transmission-line effects, thereby simplifying system design. This counter features a fully independent clock circuit. Changes at control inputs (enable  $\bar{P}$ , Enable  $\bar{T}$ , load, up/down) that will modify the operating mode have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading, or counting) will be dictated solely by the conditions meeting the stable setup and hold times.

## ■ BLOCK DIAGRAM



## ■ PIN ARRANGEMENT



## ■ RECOMMENDED OPERATING CONDITIONS

Item	Symbol	min	typ	max	Unit
Output current	$I_{OH}$	—	—	-400	$\mu A$
Output current	$I_{OL}$	—	—	8	mA
Clock frequency	$f_{clock}$	0	—	25	MHz
Clock pulse width	$t_{w(ck)}$	25	—	—	ns
Setup time	Input Data, A, B, C, D	25	—	—	ns
	Enable P, T	35	—	—	
	Load	30	—	—	
	Up/Down	35	—	—	
Hold time	$t_h$	0	—	—	ns

## ■ ELECTRICAL CHARACTERISTICS ( $T_a = -20 \sim +75^\circ\text{C}$ )

Item		Symbol	Test Conditions	min	typ*	max	Unit
Input voltage		$V_{IH}$		2	—	—	V
		$V_{IL}$		—	—	0.8	V
Output voltage		$V_{OH}$	$V_{CC} = 4.75\text{V}$ , $V_{IH} = 2\text{V}$ , $V_{IL} = 0.8\text{V}$ , $I_{OH} = -400\mu\text{A}$	2.7	—	—	V
		$V_{OL}$	$V_{CC} = 4.75\text{V}$ , $V_{IH} = 2\text{V}$ , $V_{IL} = 0.8\text{V}$	$I_{OL} = 4\text{mA}$	—	0.4	V
				$I_{OL} = 8\text{mA}$	—	0.5	V
Input current	A, B, C, D, $\bar{P}$ , U/ $\bar{D}$	$I_{IH}$	$V_{CC} = 5.25\text{V}$ , $V_I = 2.7\text{V}$	—	—	20	$\mu\text{A}$
	Clock, $\bar{T}$			—	—	20	
	Load			—	—	40	
	A, B, C, D, $\bar{P}$ , U/ $\bar{D}$	$I_{iL}$	$V_{CC} = 5.25\text{V}$ , $V_I = 0.4\text{V}$	—	—	-0.4	mA
	Clock, $\bar{T}$			—	—	-0.4	
	Load			—	—	-0.8	
	A, B, C, D, $\bar{P}$ , U/ $\bar{D}$	$I_I$	$V_{CC} = 5.25\text{V}$ , $V_I = 7\text{V}$	—	—	0.1	mA
	Clock, $\bar{T}$			—	—	0.1	
	Load			—	—	0.2	
Short-circuit output current		$I_{OS}$	$V_{CC} = 5.25\text{V}$	-20	—	-100	mA
Supply current **		$I_{CC}$	$V_{CC} = 5.25\text{V}$	—	20	34	mA
Input clamp voltage		$V_{IK}$	$V_{CC} = 4.75\text{V}$ , $I_{IK} = -18\text{mA}$	—	—	-1.5	V

\*  $V_{CC} = 5\text{V}$ ,  $T_a = 25^\circ\text{C}$

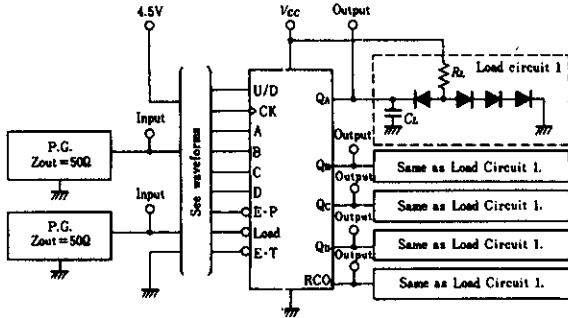
\*\*  $I_{CC}$  is measured after applying a momentary 4.5V, then ground, to the clock input with all other inputs grounded the outputs open.

## ■ SWITCHING CHARACTERISTICS ( $V_{CC} = 5\text{V}$ , $T_a = 25^\circ\text{C}$ )

Item	Symbol	Inputs	Outputs	Test Conditions	min	typ	max	Unit
Maximum count frequency	$f_{max}$			$C_L=15\text{pF}$ , $R_L=2\text{k}\Omega$	25	32	—	MHz
Propagation delay time	$t_{PLH}$	Clock	Ripple Carry		—	26	40	ns
	$t_{PHL}$				—	40	60	
	$t_{PLH}$	Clock	$Q_A\sim Q_D$		—	18	27	ns
	$t_{PHL}$				—	18	27	
	$t_{PLH}$	Enable $\bar{T}$	Ripple Carry		—	11	17	ns
	$t_{PHL}$				—	29	45	
	$t_{PLH}$	Up/Down	Ripple Carry		—	22	35	ns
	$t_{PHL}$				—	26	40	

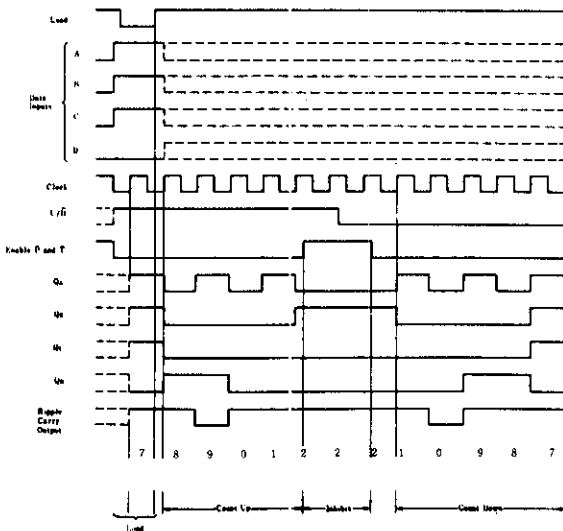
## TESTING METHOD

### 1) Test Circuit

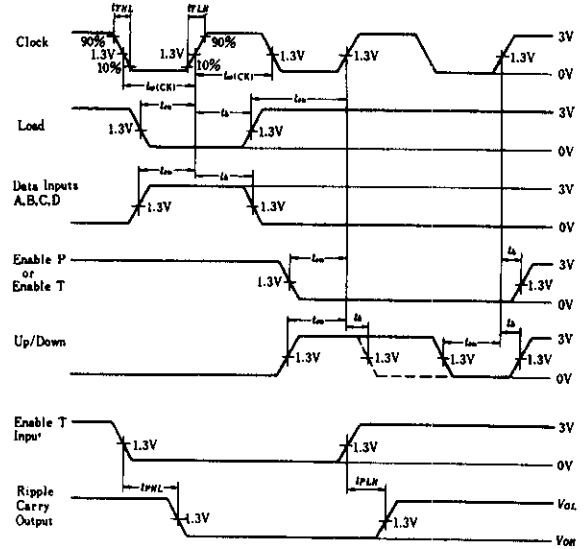


- Notes) 1.  $C_L$  includes probe and jig capacitance.  
2. All diodes are 1S2074  $\Phi$ .

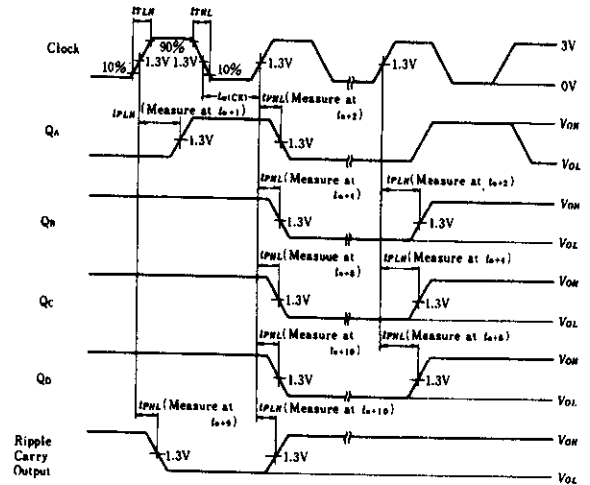
## COUNT SEQUENCE



### Waveform

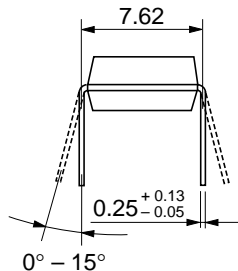
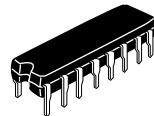
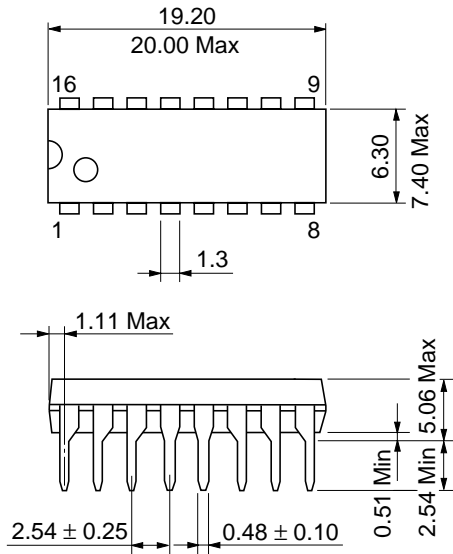


- Notes) 1.  $t_{PLH}$  and  $t_{PHL}$  from enable  $\bar{T}$  input to ripple carry output assume that the counter is at the maximum count ( $Q_A$  and  $Q_D$  high).  
2. Propagation delay time from up/down to ripple carry must be measured with the counter at either a minimum or a maximum count. As the logic level of the up/down input is changed, the ripple carry output will follow. If the count is minimum (0) the ripple carry output transition will be in phase. If the count is maximum (9) the ripple carry output will be out of phase.  
3. Input pulse:  $t_{TLH} \leq 15\text{ns}$ ,  $t_{THL} \leq 6\text{ns}$ ,  $PRR=1\text{MHz}$

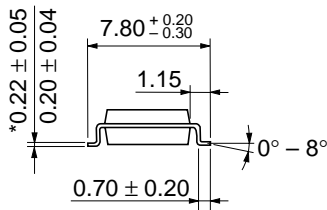
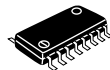
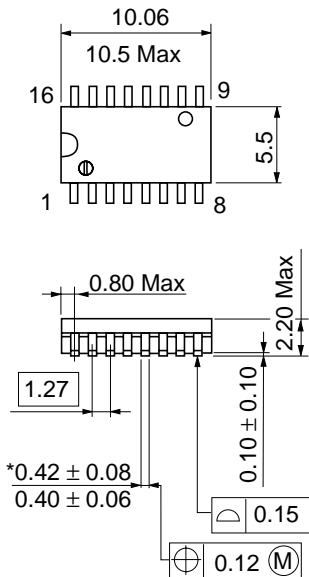


- Notes) 1. Input pulse:  $t_{TLH} \leq 15\text{ns}$ ,  $t_{THL} \leq 6\text{ns}$ ,  $PRR=1\text{MHz}$ , duty cycle 50%.  
2. For  $f_{max}$ ,  $t_{TLH} + t_{THL} \leq 2.5\text{ns}$ .  
3.  $t_n$  is the bit-time when all outputs are low.

Unit: mm

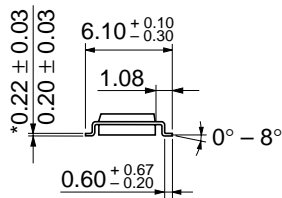
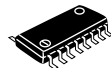
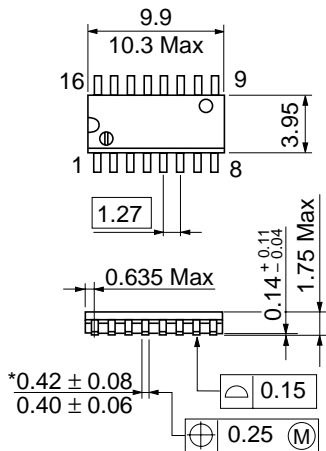


Hitachi Code	DP-16
JEDEC	Conforms
EIAJ	Conforms
Weight (reference value)	1.07 g



\*Dimension including the plating thickness  
Base material dimension

Hitachi Code	FP-16DA
JEDEC	—
EIAJ	Conforms
Weight (reference value)	0.24 g



\*Dimension including the plating thickness  
Base material dimension

Hitachi Code	FP-16DN
JEDEC	Conforms
EIAJ	Conforms
Weight (reference value)	0.15 g

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