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# HD74HC668/HD74HC669

Synchronous UP/Down Decade Counter  
Synchronous Up/Down 4-bit binary Counter

# HITACHI

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## Description

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 transission-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.

## Features

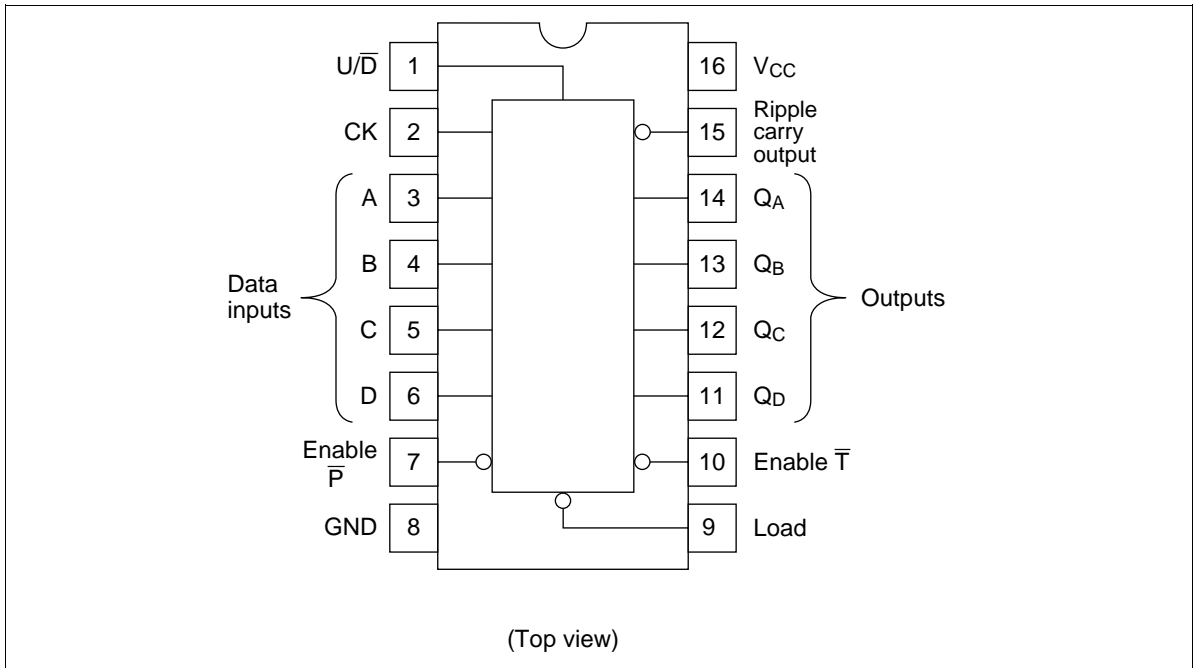
- High Speed Operation
- High Output Current: Fanout of 10 LSTTL Loads
- Wide Operating Voltage:  $V_{CC} = 2$  to 6 V
- Low Input Current: 1  $\mu$ A max

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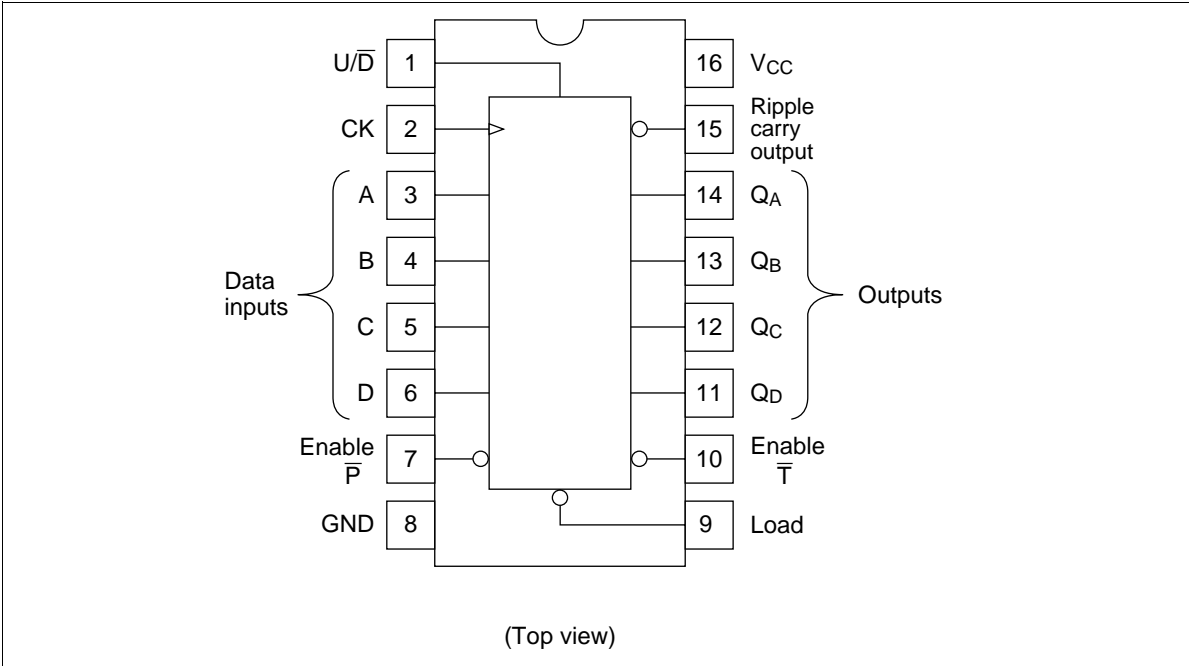
- Low Quiescent Supply Current:  $I_{CC}$  (static) = 4  $\mu$ A max ( $T_a = 25^\circ\text{C}$ )

## Pin Arrangement

### HD74HC668



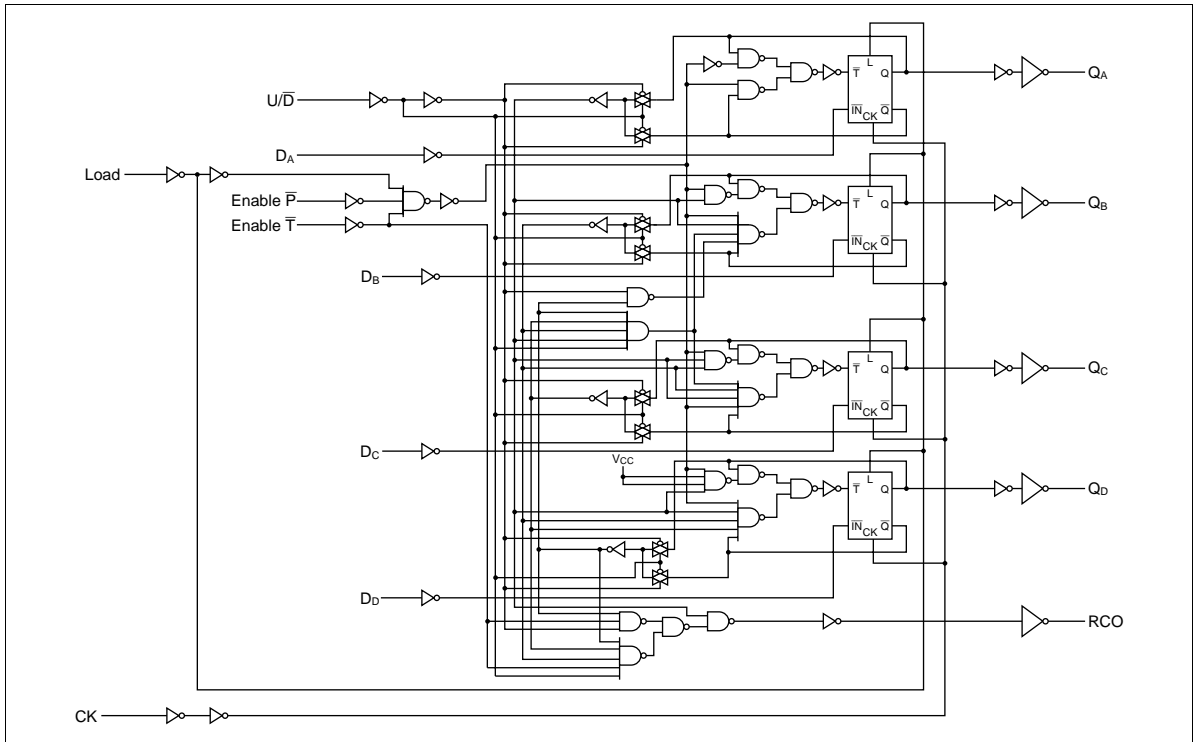
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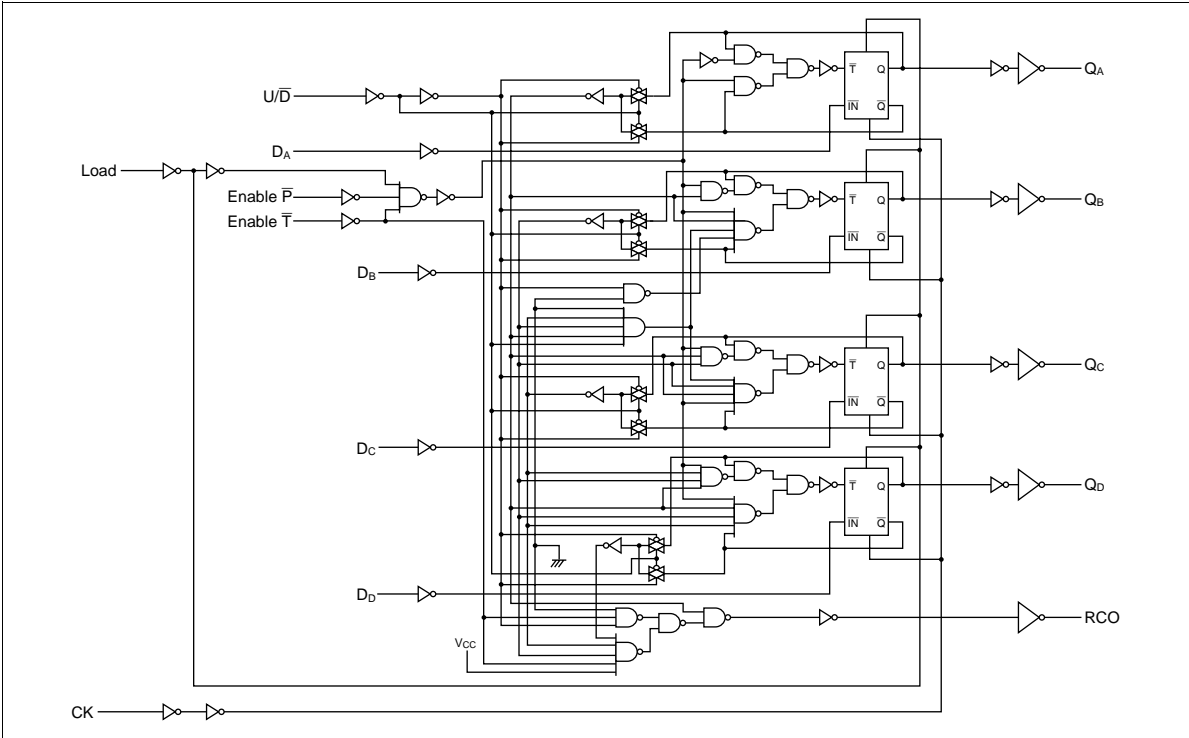
## Logic Diagram

### HD74HC668



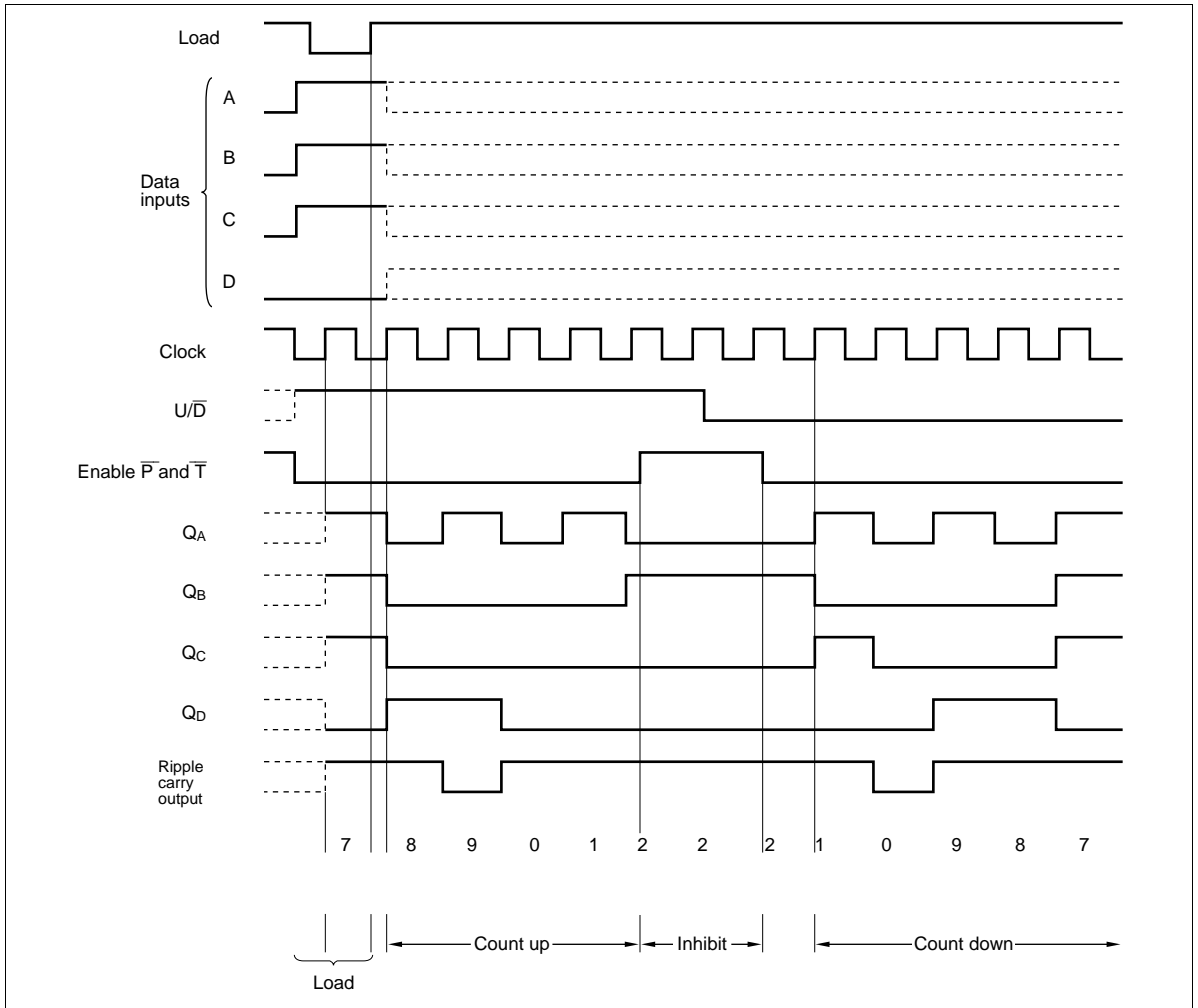
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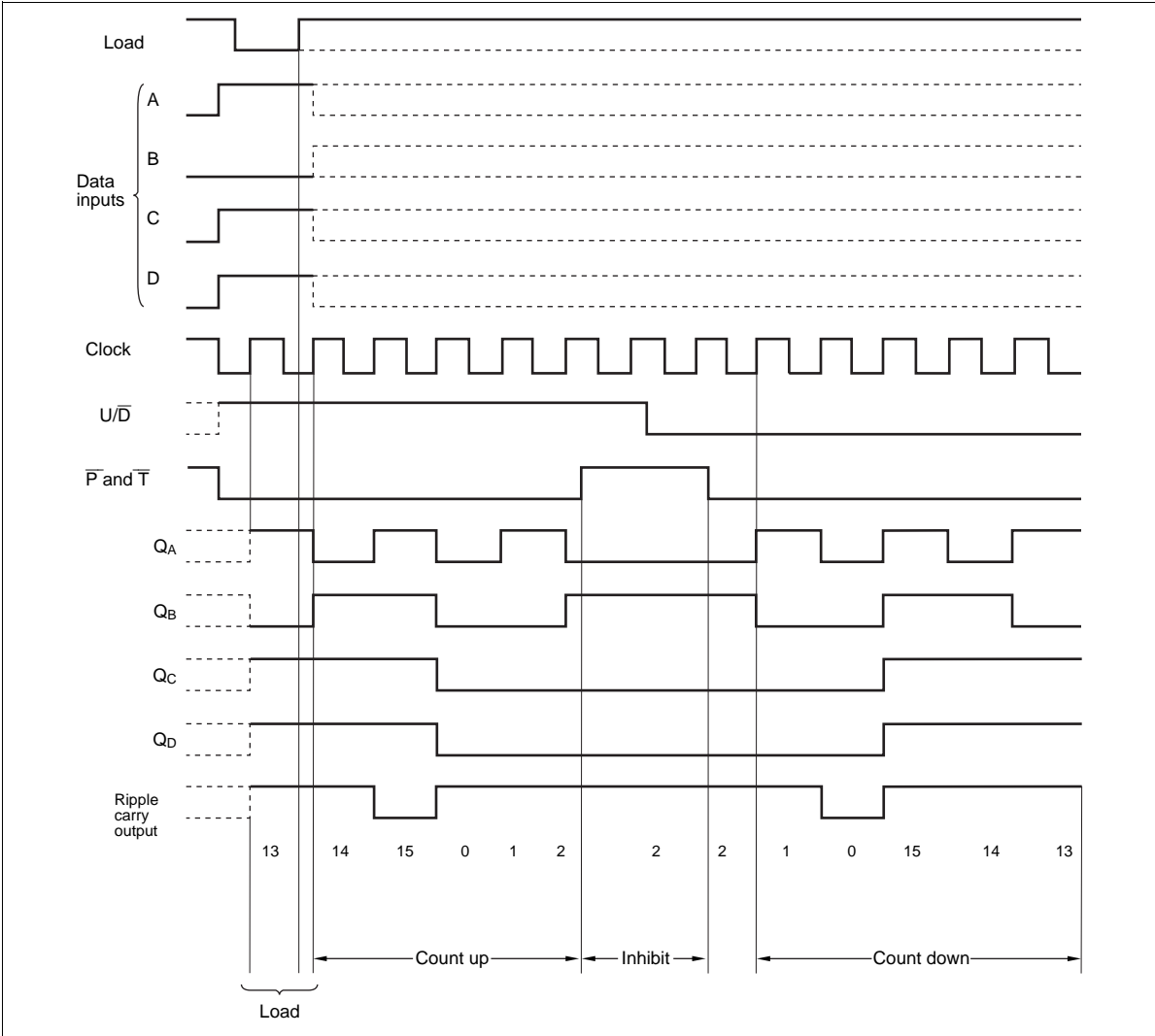


## Timing Chart

### HD74HC668



HD74HC669



## DC Characteristics

Item	Symbol	V <sub>CC</sub> (V)	Ta = 25°C			Ta = -40 to +85°C		Unit	Test Conditions	
			Min	Typ	Max	Min	Max			
Input voltage	V <sub>IH</sub>	2.0	1.5	—	—	1.5	—	V		
		4.5	3.15	—	—	3.15	—			
		6.0	4.2	—	—	4.2	—			
	V <sub>IL</sub>	2.0	—	—	0.5	—	0.5			V
		4.5	—	—	1.35	—	1.35			
		6.0	—	—	1.8	—	1.8			
Output voltage	V <sub>OH</sub>	2.0	1.9	2.0	—	1.9	—	V	Vin = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = -20 μA	
		4.5	4.4	4.5	—	4.4	—			
		6.0	5.9	6.0	—	5.9	—			
		4.5	4.18	—	—	4.13	—			I <sub>OH</sub> = -4 mA
		6.0	5.68	—	—	5.63	—			I <sub>OH</sub> = -5.2 mA
		6.0	—	0.0	0.1	—	0.1			V
	4.5	—	0.0	0.1	—	0.1				
	6.0	—	0.0	0.1	—	0.1				
	4.5	—	—	0.26	—	0.33	I <sub>OL</sub> = 4 mA			
	6.0	—	—	0.26	—	0.33	I <sub>OL</sub> = 5.2 mA			
Input current	I <sub>in</sub>	6.0	—	—	±0.1	—	±1.0	μA	Vin = V <sub>CC</sub> or GND	
Quiescent supply current	I <sub>CC</sub>	6.0	—	—	4.0	—	40	μA	Vin = V <sub>CC</sub> or GND, I <sub>out</sub> = 0 μA	



**AC Characteristics** ( $C_L = 50$  pF, Input  $t_r = t_f = 6$  ns)

Item	Symbol	$V_{CC}$ (V)	$T_a = 25^\circ\text{C}$		$T_a = -40$ to $+85^\circ\text{C}$		Unit	Test Conditions	
			Min	Typ	Max	Min			Max
Maximum clock Frequency	$f_{max}$	2.0	—	—	5	—	4	MHz	
		4.5	—	—	27	—	21		
		6.0	—	—	32	—	25		
Propagation delay time	$t_{PLH}$	2.0	—	—	200	—	250	ns	Clock to Ripple carry out
		4.5	—	—	40	—	50		
		6.0	—	—	34	—	43		
	$t_{PHL}$	2.0	—	—	225	—	280	ns	Clock to Q
		4.5	—	—	45	—	56		
		6.0	—	—	38	—	48		
	$t_{PLH}$	2.0	—	—	150	—	190	ns	Enable $\bar{T}$ to Ripple carry out
		4.5	—	—	30	—	38		
		6.0	—	—	26	—	33		
	$t_{PHL}$	2.0	—	—	200	—	250	ns	$U/\bar{D}$ to Ripple carry out
		4.5	—	—	40	—	50		
		6.0	—	—	34	—	43		
Pulse width	$t_w$	2.0	80	—	—	100	—	ns	
		4.5	16	—	—	20	—		
		6.0	14	—	—	17	—		
Setup time	$t_{su}$	2.0	100	—	—	125	—	ns	Data to Clock
		4.5	20	—	—	25	—		
		6.0	17	—	—	21	—		
	$t_{su}$	2.0	150	—	—	190	—	ns	Enable $\bar{P}$ , $\bar{T}$ to Clock
		4.5	30	—	—	38	—		
		6.0	26	—	—	33	—		
	$t_{su}$	2.0	150	—	—	190	—	ns	Loadk to Clock
		4.5	30	—	—	38	—		
		6.0	26	—	—	33	—		
	$t_{su}$	2.0	150	—	—	190	—	ns	$U/\bar{D}$ to Clock
		4.5	30	—	—	38	—		
		6.0	26	—	—	33	—		

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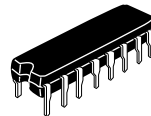
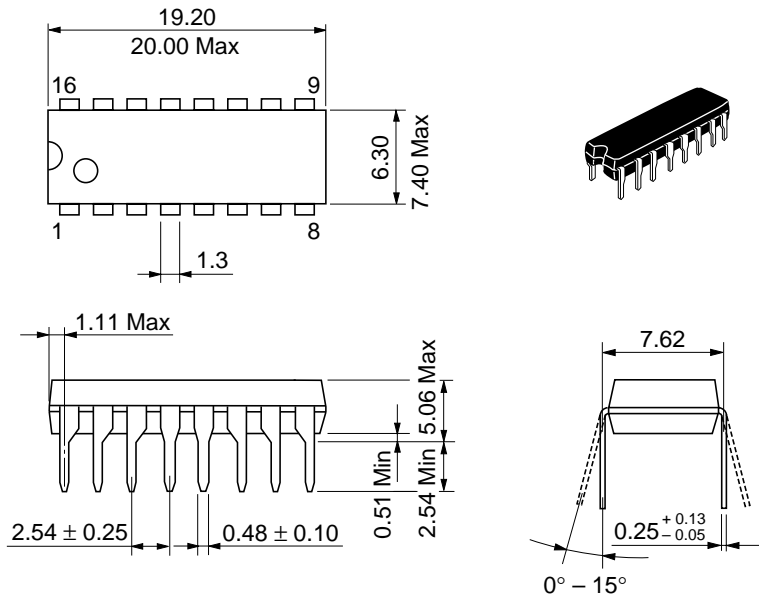
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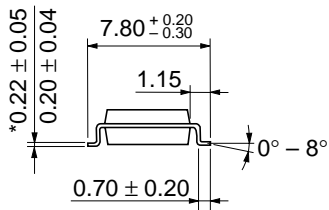
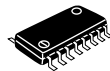
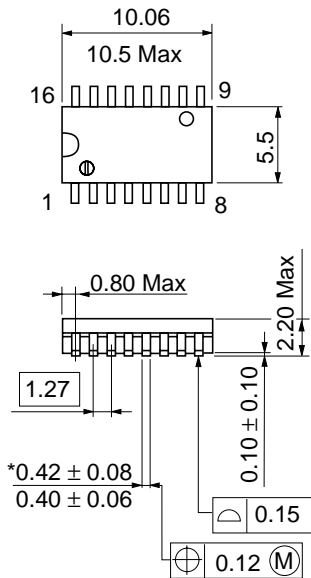
**AC Characteristics** ( $C_L = 50$  pF, Input  $t_r = t_f = 6$  ns) (cont)

Item	Symbol	$V_{CC}$ (V)	Ta = 25°C			Ta = -40 to +85°C		Unit	Test Conditions
			Min	Typ	Max	Min	Max		
Hold time	$t_h$	2.0	5	—	—	5	—	ns	
		4.5	5	—	—	5	—		
		6.0	5	—	—	5	—		
Output rise/fall time	$t_{TLH}$ $t_{THL}$	2.0	—	—	75	—	95	ns	
		4.5	—	5	15	—	19		
		6.0	—	—	13	—	16		
Input capacitance	$C_{in}$	—	—	5	10	—	10	pF	

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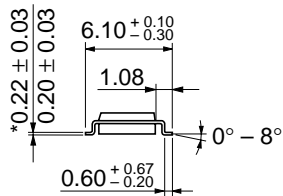
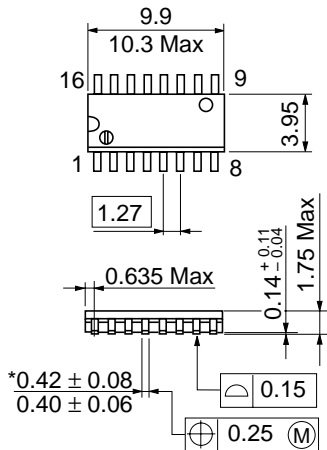


Hitachi Code	DP-16
JEDEC	Conforms
EIAJ	Conforms
Weight (reference value)	1.07 g



\*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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