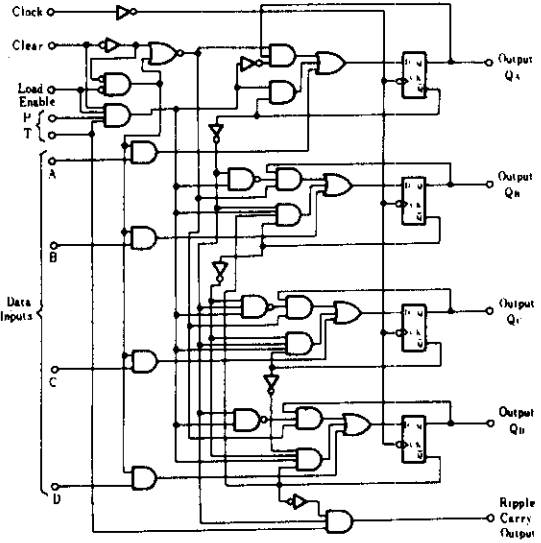
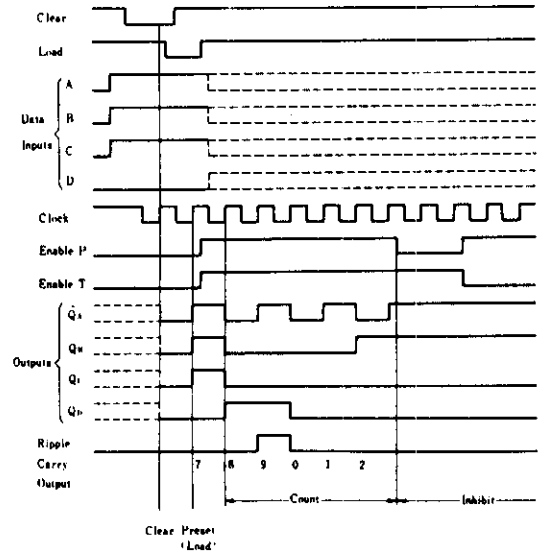


This synchronous decade counter features an internal carry look-ahead for application in high-speed counting designs. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes that are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform. This counter is fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. Low-to-high transitions at the load input should be avoided when the clock is low if the enable inputs are high at or before the transition. The clear function is synchronous and a low level at the clear input sets all four of the flip-flop outputs low after the next clock pulse, regardless of the levels of the enable inputs. This synchronous clear allows the count length to be modified easily as decoding the maximum count desired can be accomplished with one external NAND gate. The gate output is connected to the clear input to synchronously clear the counter to LLLL. Low-to-high transitions at the clear input should be avoided when the clock is low if the enable and load inputs are high at or before the transition. 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 ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the  $Q_A$  output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. High-to-low-level transitions at the enable P or T inputs should occur only when the clock input is high.

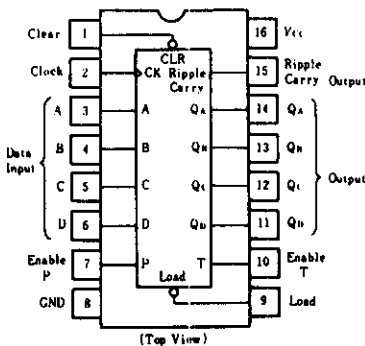
## ■ BLOCK DIAGRAM



## ■ TYPICAL CLEAR, PRESET, AND INHIBIT SEQUENCE



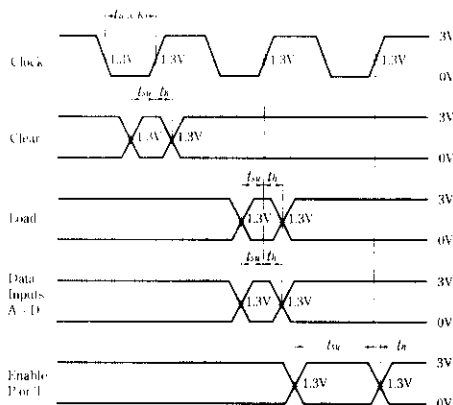
## ■ PIN ARRANGEMENT



## ■ RECOMMENDED OPERATING CONDITIONS

Item	Symbol	min	typ	max	Unit
Clock frequency	$f_{clock}$	0	—	25	MHz
Clock pulse width	$t_w(CK)$	25	—	—	ns
Clear pulse width	$t_w(CLR)$	20	—	—	ns
Setup time	A, B, C, D	20	—	—	ns
	Enable P, T	20	—	—	ns
	Load	20	—	—	ns
	Clear	20	—	—	ns
Hold time	$t_h$	3	—	—	ns

## TIMING DEFINITION



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

Item	Symbol	Test Conditions	min	typ*	max	Unit	
Input voltage	$V_{IH}$		2.0	—	—	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	
	$V_{OL}$	$V_{CC} = 4.75\text{V}$ , $V_{IH} = 2\text{V}$ , $V_{IL} = 0.8\text{V}$ , $I_{OL} = 4\text{mA}$ $I_{OL} = 8\text{mA}$	—	—	0.4 0.5	V	
Input current	Data, Enable P	$V_{CC} = 5.25\text{V}$ , $V_I = 2.7\text{V}$	—	—	20	$\mu\text{A}$	
	Load, Clock, Enable T		—	—	40		
	Clear		—	—	40		
	Data, Enable P		$V_{CC} = 5.25\text{V}$ , $V_I = 0.4\text{V}$	—	—	-0.4	mA
	Load, Clock, Enable T			—	—	-0.8	
	Clear			—	—	-0.8	
	Data, Enable P	$V_{CC} = 5.25\text{V}$ , $V_I = 7\text{V}$	—	—	0.1	mA	
	Load, Clock, Enable T		—	—	0.2		
	Clear		—	—	0.2		
Short-circuit output current	$I_{OS}$	$V_{CC} = 5.25\text{V}$	-20	—	100	mA	
Supply current**	$I_{CC}$	$V_{CC} = 5.25\text{V}$	—	18	31	mA	
	$I_{CCL}$	$V_{CC} = 5.25\text{V}$	—	19	32	mA	
Input clamp voltage	$V_{IK}$	$V_{CC} = 4.75\text{V}$ , $I_{IK} = 18\text{mA}$	—	—	1.5	V	

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

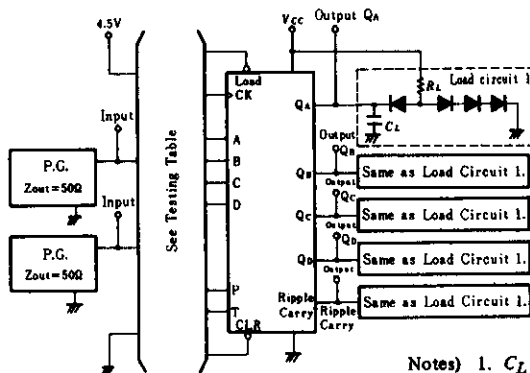
\*\*  $I_{CC}$  is measured with the load input high, then again with the load input low, with all other inputs high and all outputs open.  $I_{CCL}$  is measured with the clock input high, then again with the clock input low, with all other inputs low and all outputs open.

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

Item	Symbol	Inputs	Outputs	Test Conditions	min	typ	max	Unit
Maximum clock frequency	$f_{max}$	Clock	$Q_A \sim Q_D$	$C_L = 15\text{pF}$ , $R_L = 2\text{k}\Omega$	25	32	—	MHz
	$t_{PLH}$	Clock	Ripple		—	20	35	ns
$t_{PHL}$	Carry		—		18	35	ns	
Propagation delay time	$t_{PLH}$	Clock	$Q_A \sim Q_D$ (Load="H")		—	13	24	ns
	$t_{PHL}$				—	18	27	ns
	$t_{PLH}$	Clock	$Q_A \sim Q_D$ (Load="L")		—	13	24	ns
	$t_{PHL}$				—	18	27	ns
	$t_{PLH}$	Enable T	Ripple		—	9	14	ns
	$t_{PHL}$		Carry	—	9	14	ns	
$t_{PHL}$	Clear	$Q_A \sim Q_D$	—	20	28	ns		

## TESTING METHOD

### 1) Test Circuit



Notes) 1.  $C_L$  includes probe and jig capacitance.  
2. All diodes are 1S2074 (H)

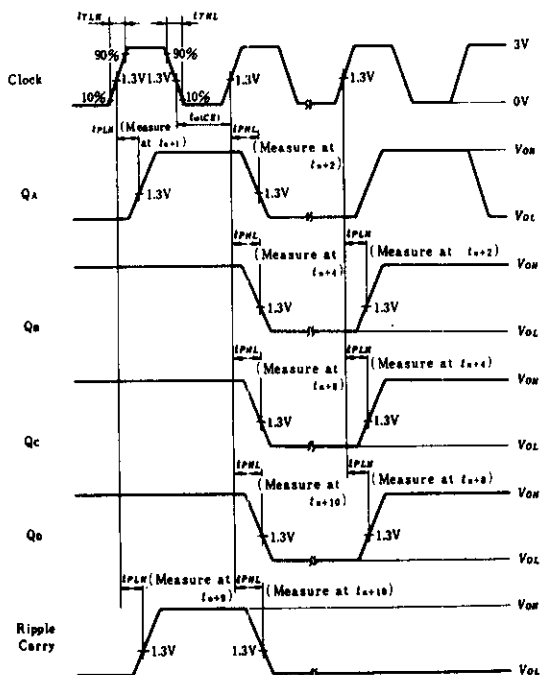
### 2) Testing Table

Item	From input to output	Inputs										Outputs				
		Clear	Load	Enable		Clock	Data				QA	QB	QC	QD	Ripple Carry	
				P	T		A	B	C	D						
$f_{max}$		4.5V	4.5V	4.5V	4.5V	IN	GND	GND	GND	GND	OUT	OUT	OUT	OUT	OUT	
$t_{PLH}$	CK → Ripple Carry	4.5V	4.5V	4.5V	4.5V	IN	GND	GND	GND	GND	—	—	—	—	OUT	
	CK → Q	4.5V	4.5V	4.5V	4.5V	IN	GND	GND	GND	GND	OUT	OUT	OUT	OUT	—	
$t_{PHL}$	CK → Q	4.5V	GND	GND	GND	IN	IN*	IN*	IN*	IN*	OUT	OUT	OUT	OUT	—	
	Enable T → Ripple Carry	4.5V	GND	4.5V	IN	IN**	4.5V	GND	GND	4.5V	—	—	—	—	OUT	
	Clear → Q	IN	GND	GND	GND	IN**	4.5V	4.5V	4.5V	4.5V	OUT	OUT	OUT	OUT	—	

\* Measuring outputs correspond to this condition, each outputs ( $Q_A$ ,  $Q_B$ ,  $Q_C$ , and  $Q_D$ ) must not be over the following rate, "H", "L", "L", and "H".

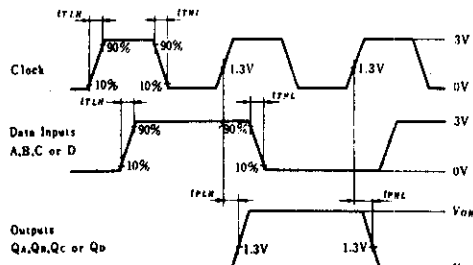
\*\* For initialized

### 3) Waveform—1 $f_{max}$ , $t_{PLH}$ , $t_{PHL}$ (Clock → Q, Ripple Carry)



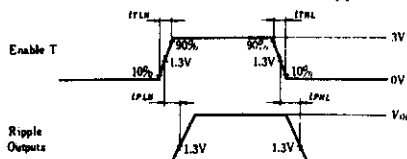
Notes) 1. Clock input pulse;  $t_{TLH} \leq 15ns$ ,  $t_{THL} \leq 6ns$ ,  $PRR=1MHz$ , duty cycle=50% and for  $f_{max}$ ,  $t_{TLH} \leq t_{THL} \leq 2.5ns$ .  
2.  $t_n$  is reference bit time when all outputs are low.

### Waveform—2 $t_{PLH}$ , $t_{PHL}$ (Clock → Q)



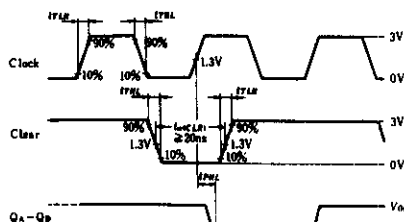
Notes) Input pulse:  $t_{TLH} \leq 15ns$ ,  $t_{THL} \leq 6ns$ ,  $PRR=1MHz$ , duty cycle 50%, Data input:  $PRR=500kHz$ , duty cycle 50%

### Waveform—3 $t_{PLH}$ , $t_{PHL}$ (Enable T → Ripple Carry)



Note) Input pulse:  $t_{TLH} \leq 15ns$ ,  $t_{THL} \leq 6ns$ ,  $PRR=1MHz$

### Waveform—4 $t_{PHL}$ (Clear → Q)



Note) Input pulse:  $t_{TLH} \leq 15ns$ ,  $t_{THL} \leq 6ns$

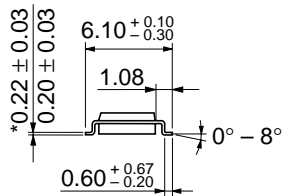
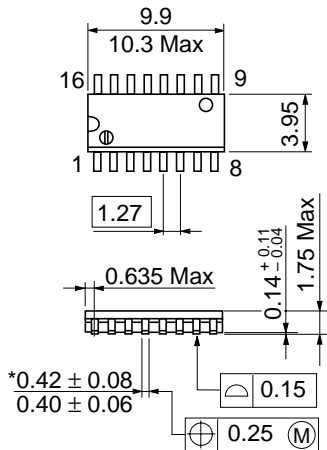


Hitachi Code	DP-16
JEDEC	Conforms
EIAJ	Conforms
Weight (reference value)	1.07 g



\*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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