

# HD74LS160A

## Synchronous Decade Counter (direct clear)

REJ03D0444-0300  
 Rev.3.00  
 Jul.15.2005

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 changes 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 output 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 of this device should be avoided when the clock is low if the enable inputs are high at or before the transition. The clear function is asynchronous and a low level at the clear input sets all four of the flip-flop outputs. The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function is 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<sub>A</sub> 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.

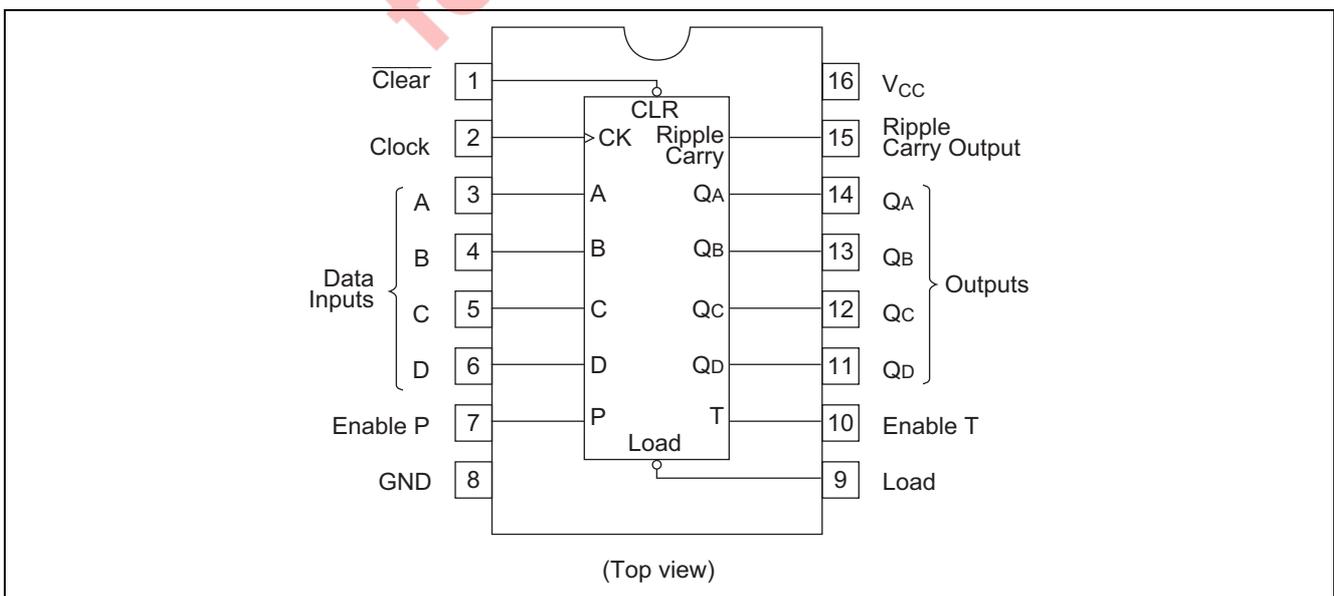
### Features

- Ordering Information

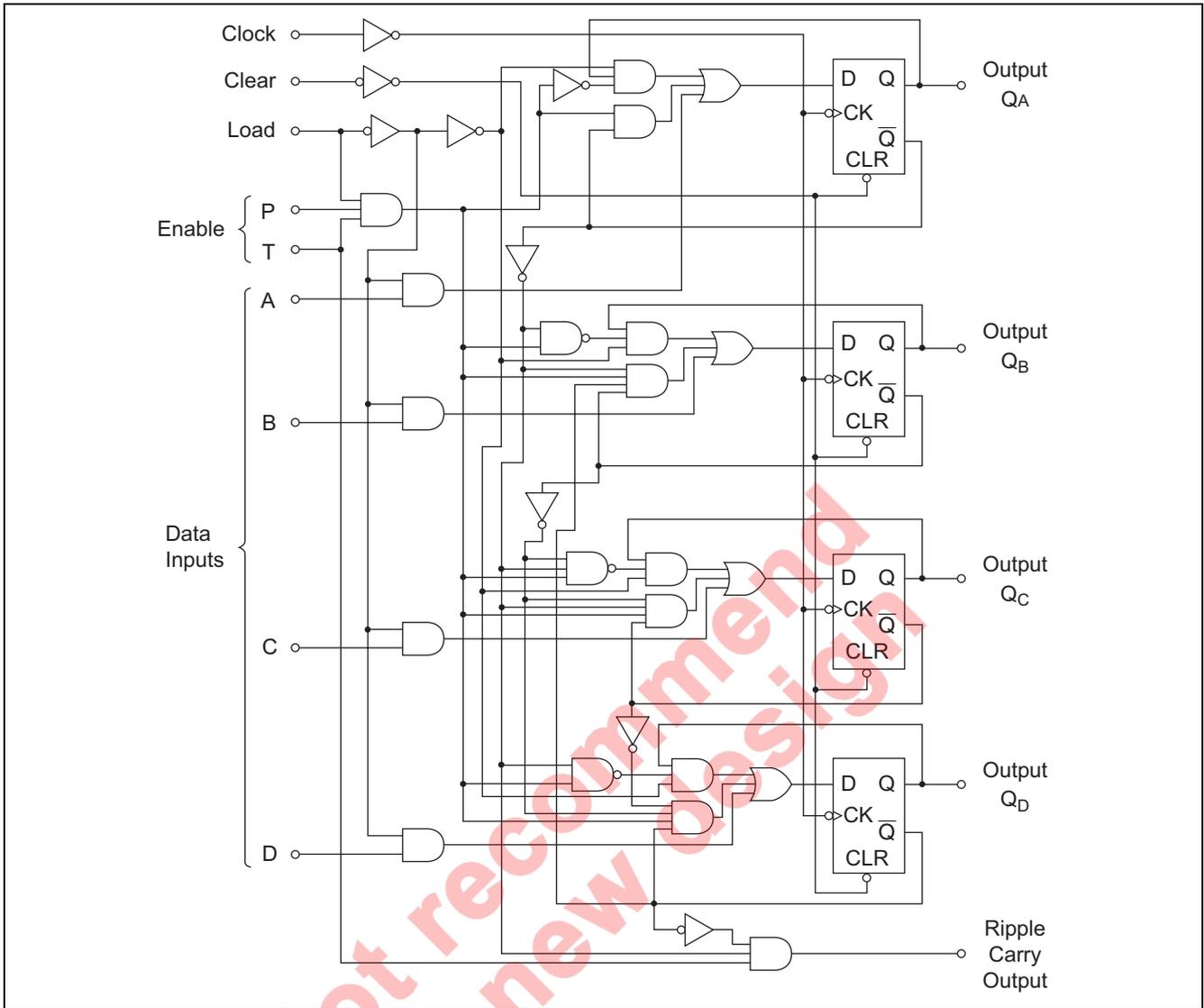
Part Name	Package Type	Package Code (Previous Code)	Package Abbreviation	Taping Abbreviation (Quantity)
HD74LS160AP	DILP-16 pin	PRDP0016AE-B (DP-16FV)	P	—
HD74LS160AFPEL	SOP-16 pin (JEITA)	PRSP0016DH-B (FP-16DAV)	FP	EL (2,000 pcs/reel)

Note: Please consult the sales office for the above package availability.

### Pin Arrangement



Block Diagram



Absolute Maximum Ratings

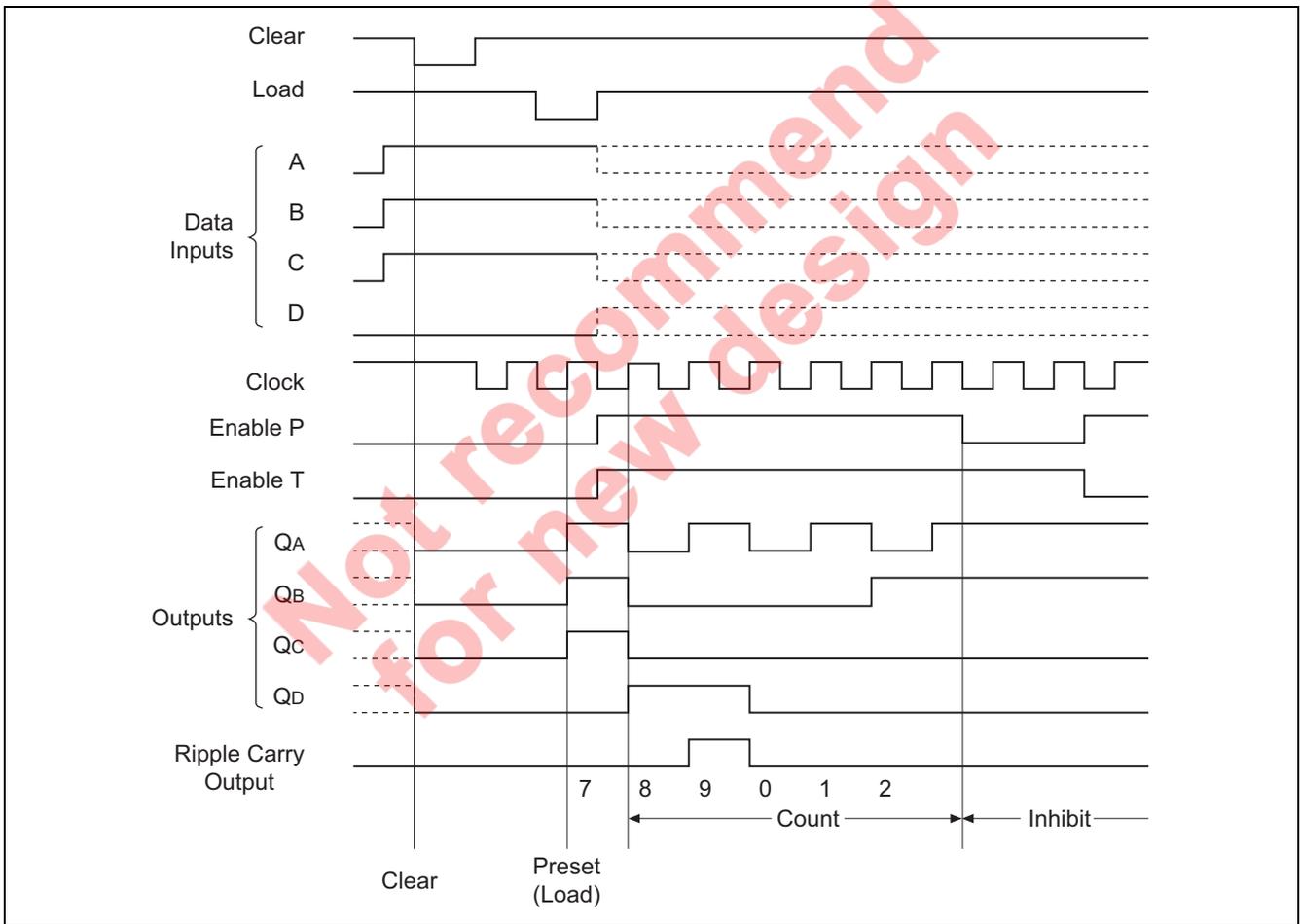
Item	Symbol	Ratings	Unit
Supply voltage	$V_{CC}$	7	V
Input voltage	$V_{IN}$	7	V
Power dissipation	$P_T$	400	mW
Storage temperature	$T_{stg}$	-65 to +150	°C

Note: Voltage value, unless otherwise noted, are with respect to network ground terminal.

### Recommended Operating Conditions

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	$V_{CC}$	4.75	5.00	5.25	V
Output current	$I_{OH}$	—	—	-400	$\mu A$
	$I_{OL}$	—	—	8	mA
Operating temperature	$T_{opr}$	-20	25	75	$^{\circ}C$
Clock frequency	$f_{clock}$	0	—	25	MHz
Clock pulse width	$t_w (clock)$	25	—	—	ns
Clear pulse width	$t_w (clear)$	20	—	—	ns
Setup time	A, B, C, D	20	—	—	ns
	Enable P, T	20	—	—	ns
	Load	20	—	—	ns
Hold time	$t_h$	3	—	—	ns

### Typical Clear, Preset, and Inhibit Sequence



**Electrical Characteristics**

(Ta = -20 to +75 °C)

Item		Symbol	min.	typ.*	max.	Unit	Condition
Input voltage		V <sub>IH</sub>	2.0	—	—	V	
		V <sub>IL</sub>	—	—	0.8	V	
Output voltage		V <sub>OH</sub>	2.7	—	—	V	V <sub>CC</sub> = 4.75 V, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V, I <sub>OH</sub> = -400 μA
		V <sub>OL</sub>	—	—	0.4	V	V <sub>CC</sub> = 4.75 V, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V
—	—		0.5				
Input current	Data, Enable P	I <sub>IH</sub>	—	—	20	μA	V <sub>CC</sub> = 5.25 V, V <sub>I</sub> = 2.7 V
	Load, Clock, Enable T		—	—	40		
	Clear		—	—	20		
	Data, Enable P	I <sub>IL</sub>	—	—	-0.4	mA	V <sub>CC</sub> = 5.25 V, V <sub>I</sub> = 0.4 V
	Load, Clock, Enable T		—	—	-0.8		
	Clear		—	—	-0.4		
	Data, Enable P	I <sub>I</sub>	—	—	0.1	mA	V <sub>CC</sub> = 5.25 V, V <sub>I</sub> = 7 V
	Load, Clock, Enable T		—	—	0.2		
	Clear		—	—	0.1		
Short-circuit output current		I <sub>OS</sub>	-20	—	-100	mA	V <sub>CC</sub> = 5.25 V
Supply current**		I <sub>CCH</sub>	—	18	31	mA	V <sub>CC</sub> = 5.25 V
		I <sub>CCL</sub>	—	19	32	mA	V <sub>CC</sub> = 5.25 V
Input clamp voltage		V <sub>IK</sub>	—	—	-1.5	V	V <sub>CC</sub> = 4.75 V, I <sub>IN</sub> = -18 mA

Notes: \* V<sub>CC</sub> = 5 V, Ta = 25°C

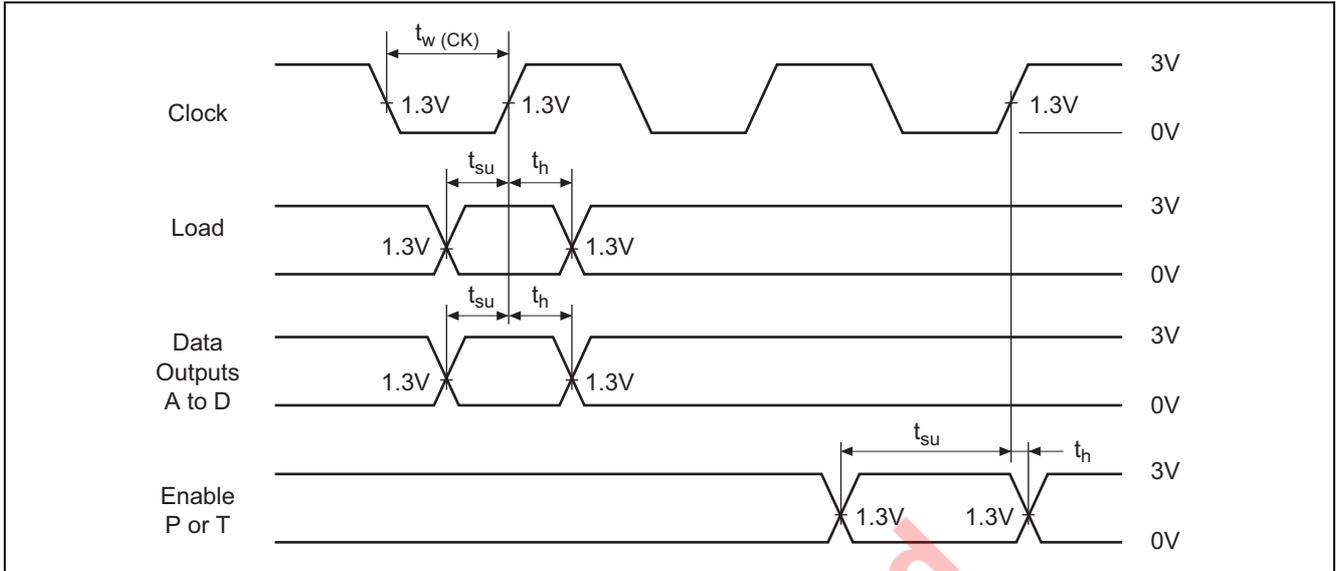
\*\* I<sub>CCH</sub> is measured with the load input high, then again with the load input low, with all other inputs high and all outputs open. I<sub>CCL</sub> is measured with the clock input high, then again with the clock input low, with all other inputs low and all outputs open.

**Switching Characteristics**

(V<sub>CC</sub> = 5 V, Ta = 25°C)

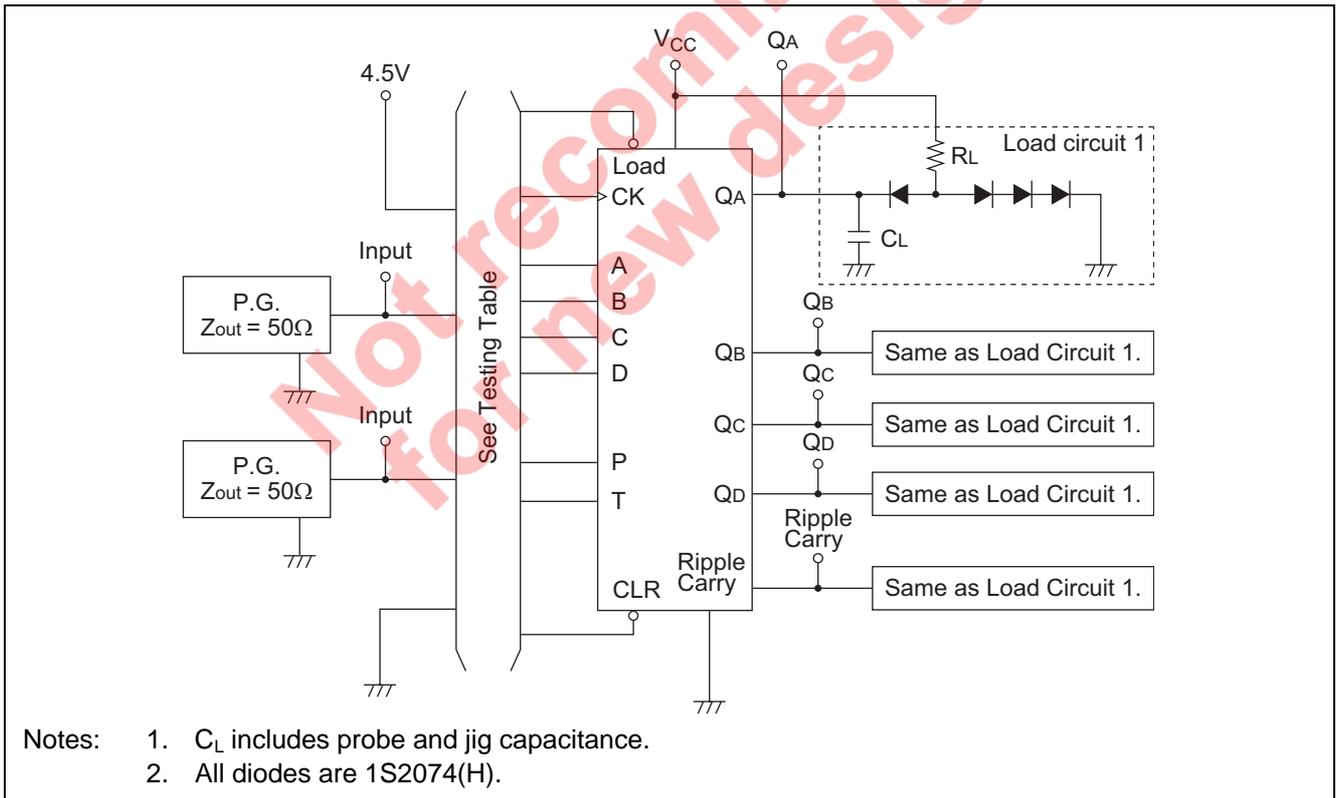
Item	Symbol	Inputs	Outputs	min.	typ.	max.	Unit	Condition
Maximum clock frequency	f <sub>max</sub>	Clock	Q <sub>A</sub> to Q <sub>D</sub>	25	32	—	MHz	C <sub>L</sub> = 15 pF, R <sub>L</sub> = 2 kΩ
Propagation delay time	t <sub>PLH</sub>	Clock	Ripple	—	20	35	ns	
	t <sub>PHL</sub>		Carry	—	18	35	ns	
	t <sub>PLH</sub>	Clock (Load = "H")	Q <sub>A</sub> to Q <sub>D</sub>	—	13	24	ns	
	t <sub>PHL</sub>			—	18	27	ns	
	t <sub>PLH</sub>	Clock (Load = "L")	Q <sub>A</sub> to Q <sub>D</sub>	—	13	24	ns	
	t <sub>PHL</sub>			—	18	27	ns	
	t <sub>PLH</sub>	Enable T	Ripple Carry	—	9	14	ns	
	t <sub>PHL</sub>			—	9	14	ns	
t <sub>PHL</sub>	Clear	Q <sub>A</sub> to Q <sub>D</sub>	—	20	28	ns		

### Timing Method



### Testing Method

#### Test Circuit



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

Testing Table

Item	From input to output	Inputs								
		Clear	Load	Enable		Clock	Data			
				P	T		A	B	C	D
$f_{max}$		4.5V	4.5V	4.5V	4.5V	IN	GND	GND	GND	GND
$t_{PLH}$ $t_{PHL}$	CK Ripply → Carry	4.5V	4.5V	4.5V	4.5V	IN	GND	GND	GND	GND
	CK → Q	4.5V	4.5V	4.5V	4.5V	IN	GND	GND	GND	GND
	CK → Q	4.5V	GND	GND	GND	IN	IN*	IN*	IN*	IN*
	Enable T → Ripple Carry	4.5V	GND	4.5V	IN	IN**	4.5V	GND	GND	4.5V
	CLR → Q	IN	GND	GND	GND	IN**	4.5V	4.5V	4.5V	4.5V

Notes: \* 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".

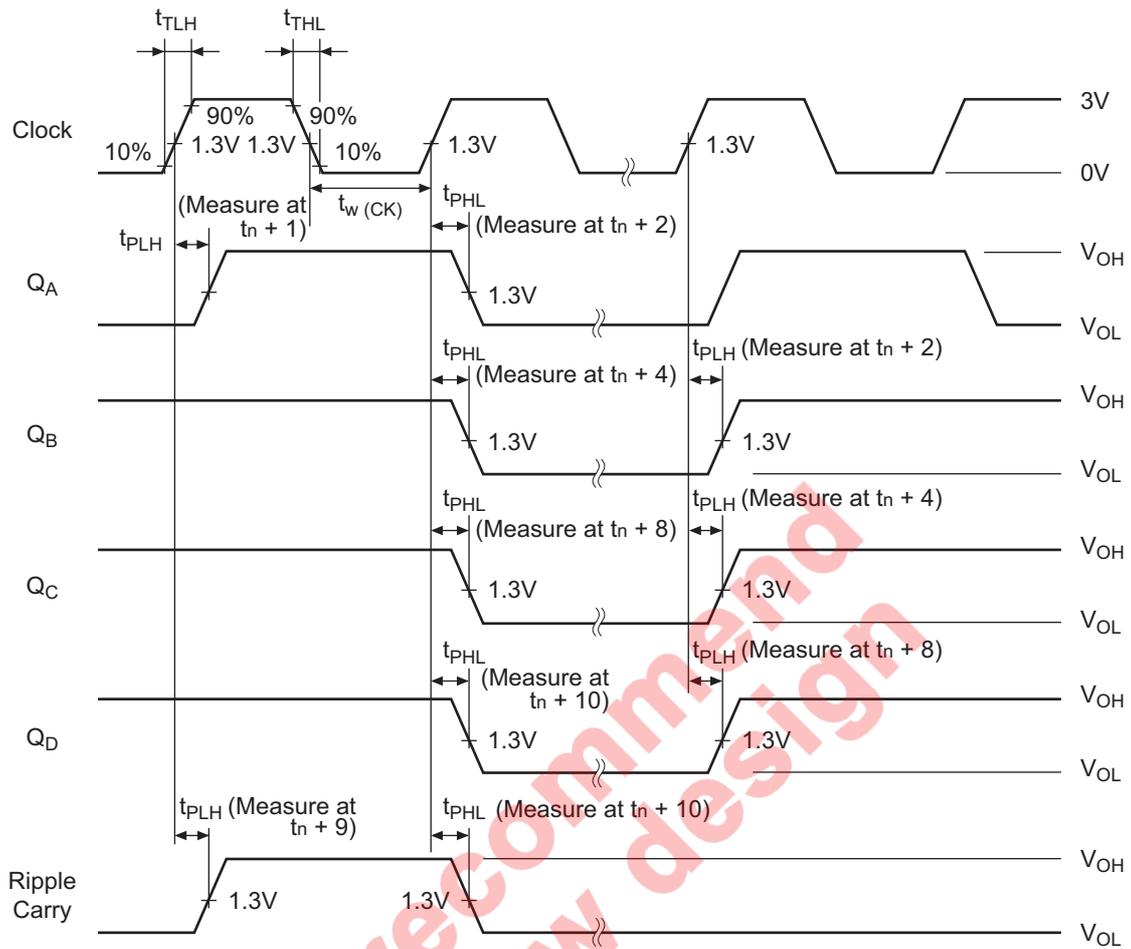
\*\* For initialized

Item	From input to output	Outputs				
		$Q_A$	$Q_B$	$Q_C$	$Q_D$	Ripple Carry
$f_{max}$		OUT	OUT	OUT	OUT	OUT
$t_{PLH}$ $t_{PHL}$	CK→Ripple Carry	—	—	—	—	OUT
	CK→Q	OUT	OUT	OUT	OUT	—
	CK→Q	OUT	OUT	OUT	OUT	—
	Enable T→Ripple Carry	—	—	—	—	OUT
	CLR→Q	OUT	OUT	OUT	OUT	—

Not recommended for new design

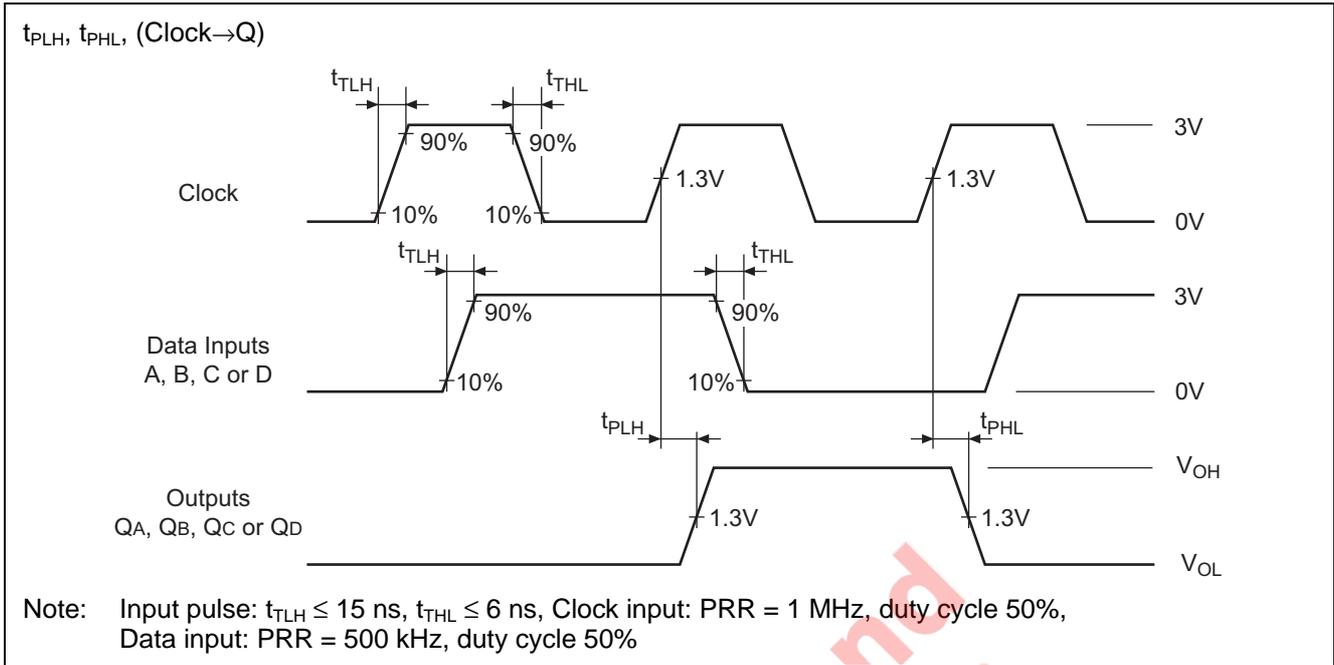
Waveforms 1

$f_{max}$ ,  $t_{PLH}$ ,  $t_{PHL}$ , (Clock→Q, Ripple Carry)

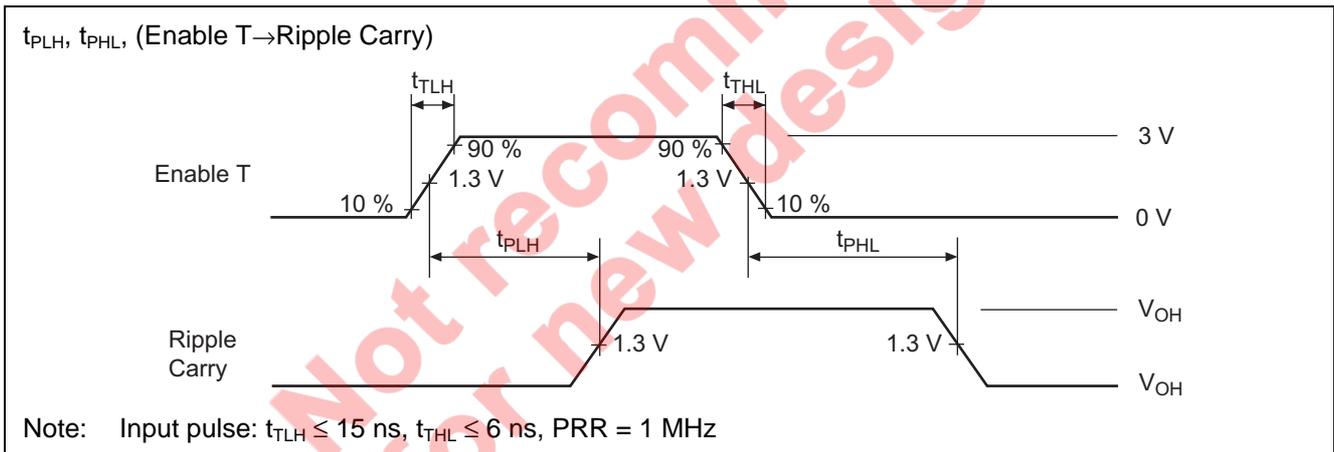


Note: Clock input pulse;  $t_{TLH} \leq 15$  ns,  $t_{THL} \leq 6$  ns, PRR = 1 MHz, duty cycle 50%  
 and :  $f_{max} t_{TLH} = t_{THL} \leq 2.5$  ns.  
 $t_n$  is reference bit time when all outputs are low.

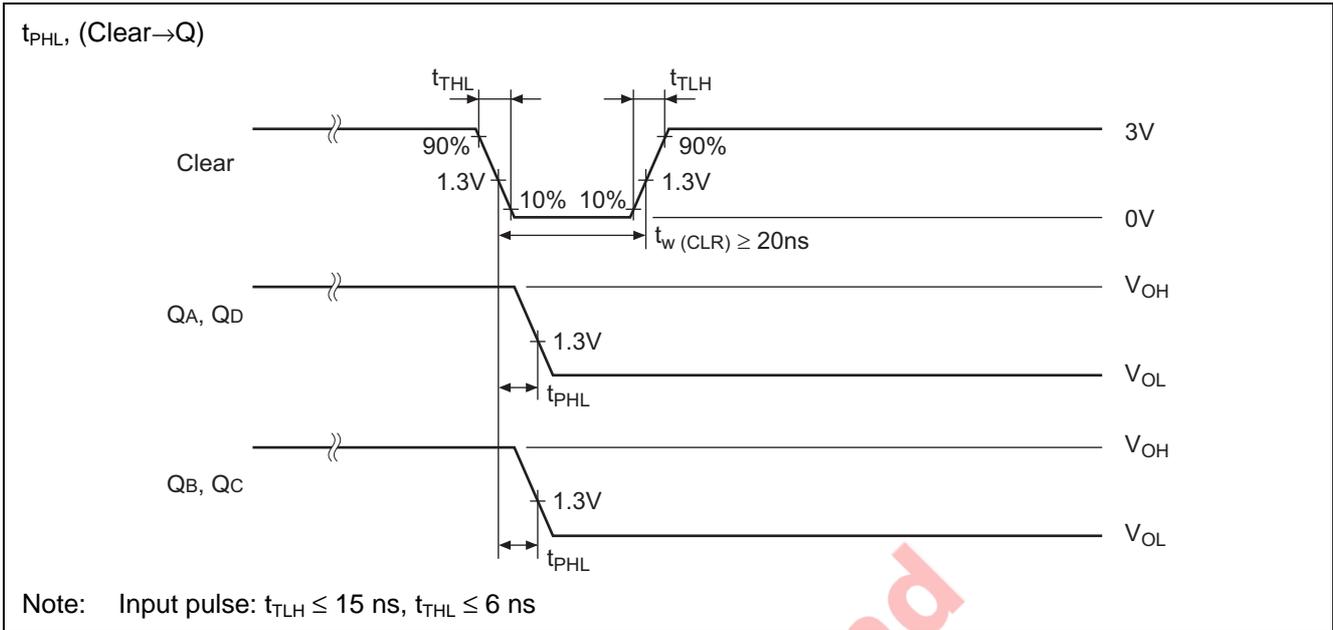
Waveforms 2



Waveforms 3



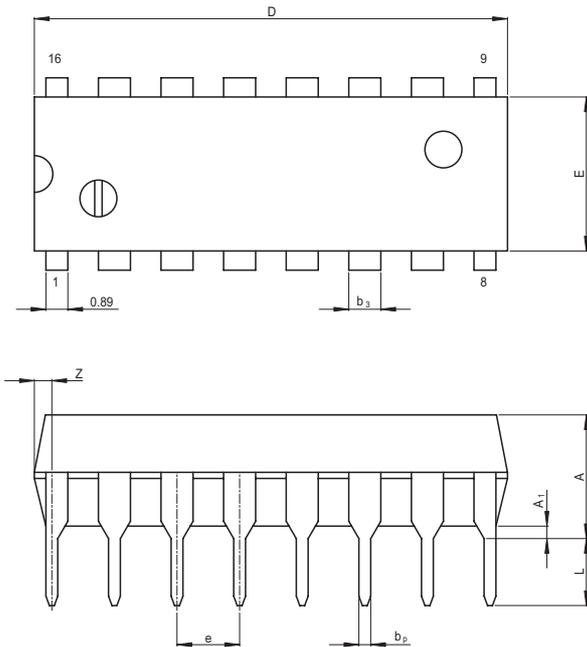
Waveforms 4



Not recommend  
for new design

Package Dimensions

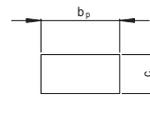
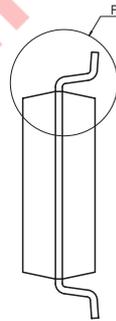
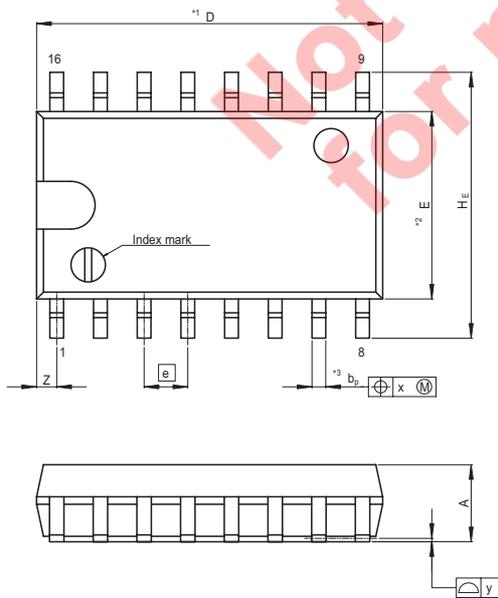
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-DIP16-6.3x19.2-2.54	PRDP0016AE-B	DP-16FV	1.05g



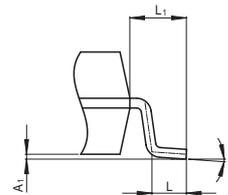
Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
e <sub>1</sub>	—	7.62	—
D	—	19.2	20.32
E	—	6.3	7.4
A	—	—	5.06
A <sub>1</sub>	0.51	—	—
b <sub>P</sub>	0.40	0.48	0.56
b <sub>3</sub>	—	1.30	—
c	0.19	0.25	0.31
θ	0°	—	15°
e	2.29	2.54	2.79
Z	—	—	1.12
L	2.54	—	—

(Ni/Pd/Au plating)

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP16-5.5x10.06-1.27	PRSP0016DH-B	FP-16DAV	0.24g



Terminal cross section (Ni/Pd/Au plating)



Detail F

NOTE)  
 1. DIMENSIONS\*1 (Nom)\*AND\*2 DO NOT INCLUDE MOLD FLASH.  
 2. DIMENSION\*3 DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	10.06	10.5
E	—	5.50	—
A <sub>2</sub>	—	—	—
A <sub>1</sub>	0.00	0.10	0.20
A	—	—	2.20
b <sub>P</sub>	0.34	0.40	0.46
b <sub>1</sub>	—	—	—
c	0.15	0.20	0.25
c <sub>1</sub>	—	—	—
θ	0°	—	8°
H <sub>E</sub>	7.50	7.80	8.00
e	—	1.27	—
x	—	—	0.12
y	—	—	0.15
Z	—	—	0.80
L	0.50	0.70	0.90
L <sub>1</sub>	—	1.15	—

## Renesas Technology Corp. Sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

Keep safety first in your circuit designs!

1. Renesas Technology Corp. puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corp. product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corp. or a third party.
2. Renesas Technology Corp. assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.
3. All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corp. without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corp. or an authorized Renesas Technology Corp. product distributor for the latest product information before purchasing a product listed herein.  
The information described here may contain technical inaccuracies or typographical errors.  
Renesas Technology Corp. assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.  
Please also pay attention to information published by Renesas Technology Corp. by various means, including the Renesas Technology Corp. Semiconductor home page (<http://www.renesas.com>).
4. When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corp. assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corp. semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corp. or an authorized Renesas Technology Corp. product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
6. The prior written approval of Renesas Technology Corp. is necessary to reprint or reproduce in whole or in part these materials.
7. If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.  
Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
8. Please contact Renesas Technology Corp. for further details on these materials or the products contained therein.



### RENEASAS SALES OFFICES

<http://www.renesas.com>

Refer to "<http://www.renesas.com/en/network>" for the latest and detailed information.

#### **Renesas Technology America, Inc.**

450 Holger Way, San Jose, CA 95134-1368, U.S.A  
Tel: <1> (408) 382-7500, Fax: <1> (408) 382-7501

#### **Renesas Technology Europe Limited**

Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.  
Tel: <44> (1628) 585-100, Fax: <44> (1628) 585-900

#### **Renesas Technology Hong Kong Ltd.**

7th Floor, North Tower, World Finance Centre, Harbour City, 1 Canton Road, Tsimshatsui, Kowloon, Hong Kong  
Tel: <852> 2265-6688, Fax: <852> 2730-6071

#### **Renesas Technology Taiwan Co., Ltd.**

10th Floor, No.99, Fushing North Road, Taipei, Taiwan  
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

#### **Renesas Technology (Shanghai) Co., Ltd.**

Unit2607 Ruijing Building, No.205 Maoming Road (S), Shanghai 200020, China  
Tel: <86> (21) 6472-1001, Fax: <86> (21) 6415-2952

#### **Renesas Technology Singapore Pte. Ltd.**

1 Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632  
Tel: <65> 6213-0200, Fax: <65> 6278-8001

#### **Renesas Technology Korea Co., Ltd.**

Kukje Center Bldg. 18th Fl., 191, 2-ka, Hangang-ro, Yongsan-ku, Seoul 140-702, Korea  
Tel: <82> 2-796-3115, Fax: <82> 2-796-2145

#### **Renesas Technology Malaysia Sdn. Bhd.**

Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No.18, Jalan Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: <603> 7955-9390, Fax: <603> 7955-9510