

# HD74HC190, HD74HC191

Synchronous Up/Down Decade Counter (Single Clock Line)

Synchronous Up/Down 4-bit Binary Counter (Single Clock Line)

REJ03D0587-0300

Rev.3.00

Jan 31, 2006

## Description

The HD74HC190 is a 4-bit decade counter and the HD74HC191 is a 4-bit binary counter. Synchronous counting operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple clock) counters.

The outputs of the four flip-flops are triggered on a low-to-high-level transition of the clock input if the Enable G input is low. A high at Enable G inhibits counting. The direction of the count is determined by the level of the Down/ Up ( $D/\bar{U}$ ) input. When  $D/\bar{U}$  is low, the counter counts up and when  $D/\bar{U}$  is high, it counts down.

These counters feature a fully independent clock circuit. Changes at the control inputs ( $D/\bar{U}$ ) that will modify the operating mode have no effect on the contents of the counter until clocking occurs. The function of the counter will be dictated solely by the condition meeting the stable setup and hold times.

These counters are fully programmable; that is, the outputs may each be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change to agree with the data inputs independently of the level of the clock input. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

Two outputs have been made available to perform the cascading function. Ripple clock and maximum/minimum count. The latter output produces a high-level output pulse with a duration approximately equal to one complete cycle of the clock while the count is zero (all outputs low) counting down or maximum (9 or 15) counting up. The ripple clock output produces a low-level output pulse under those same conditions but only while the clock input is low. The counters can be easily cascaded by feeding the ripple clock output to the enable input of the succeeding counter if parallel clocking is used, or to the clock input if parallel enabling is used. The maximum/minimum count output can be used to accomplish look-ahead for high-speed operation.

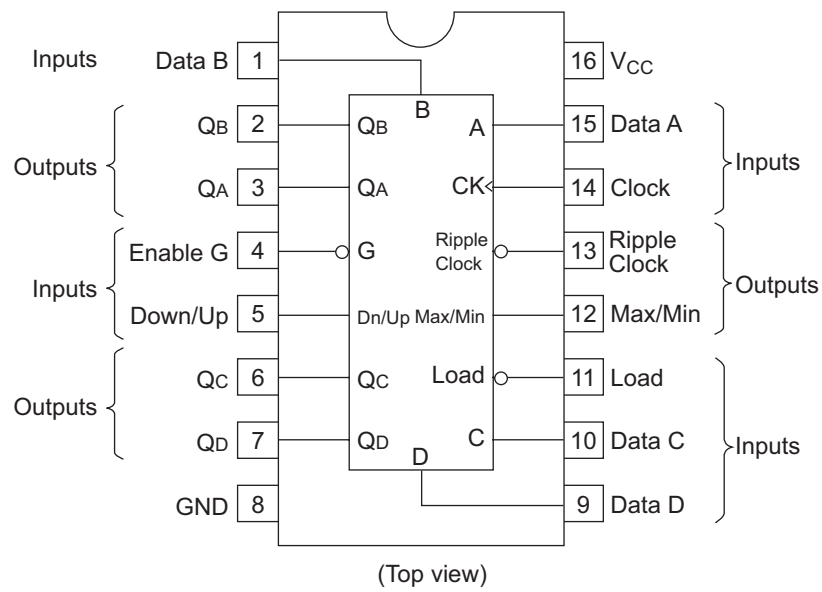
## Features

- High Speed Operation:  $t_{pd}$  (Clock to Q) = 22 ns typ ( $C_L = 50$  pF)
- High Output Current: Fanout of 10 LSTTL Loads
- Wide Operating Voltage:  $V_{CC} = 2$  to 6 V
- Low Input Current: 1  $\mu$ A max
- Low Quiescent Supply Current:  $I_{CC}$  (static) = 4  $\mu$ A max ( $T_a = 25^\circ\text{C}$ )
- Ordering Information

| Part Name                      | Package Type       | Package Code (Previous Code) | Package Abbreviation | Taping Abbreviation (Quantity) |
|--------------------------------|--------------------|------------------------------|----------------------|--------------------------------|
| HD74HC190P<br>HD74HC191P       | DILP-16 pin        | PRDP0016AE-B<br>(DP-16FV)    | P                    | —                              |
| HD74HC190FPEL<br>HD74HC191FPEL | SOP-16 pin (JEITA) | PRSP0016DH-B<br>(FP-16DAV)   | FP                   | EL (2,000 pcs/reel)            |
| HD74HC190RPEL<br>HD74HC191RPEL | SOP-16 pin (JEDEC) | PRSP0016DG-A<br>(FP-16DNV)   | RP                   | EL (2,500 pcs/reel)            |

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

## Pin Arrangement

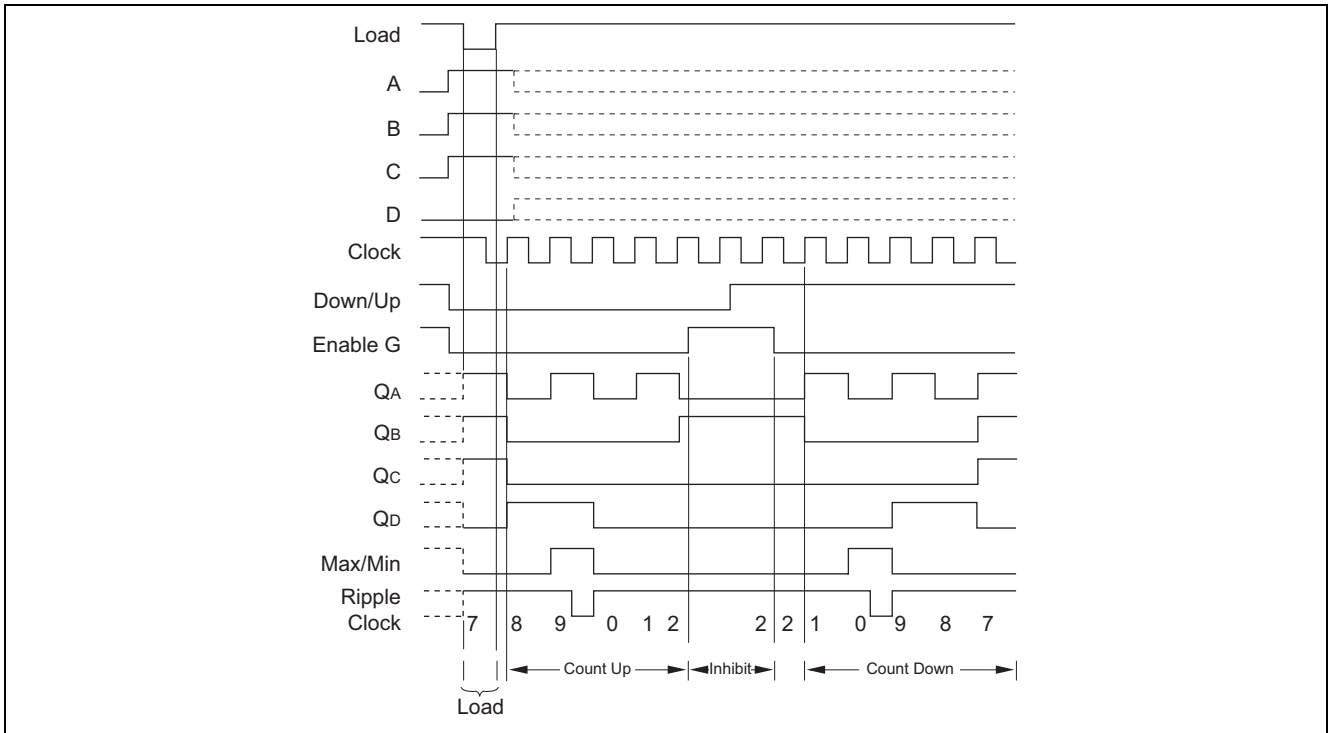


## Timing Chart

### HD74HC190

Illustrated below is the following sequence:

1. Load (preset) to BCD seven.
2. Count up to eight, nine (maximum), zero, one and two.
3. Inhibit
4. Count down to one, zero (minimum), nine, eight and seven.

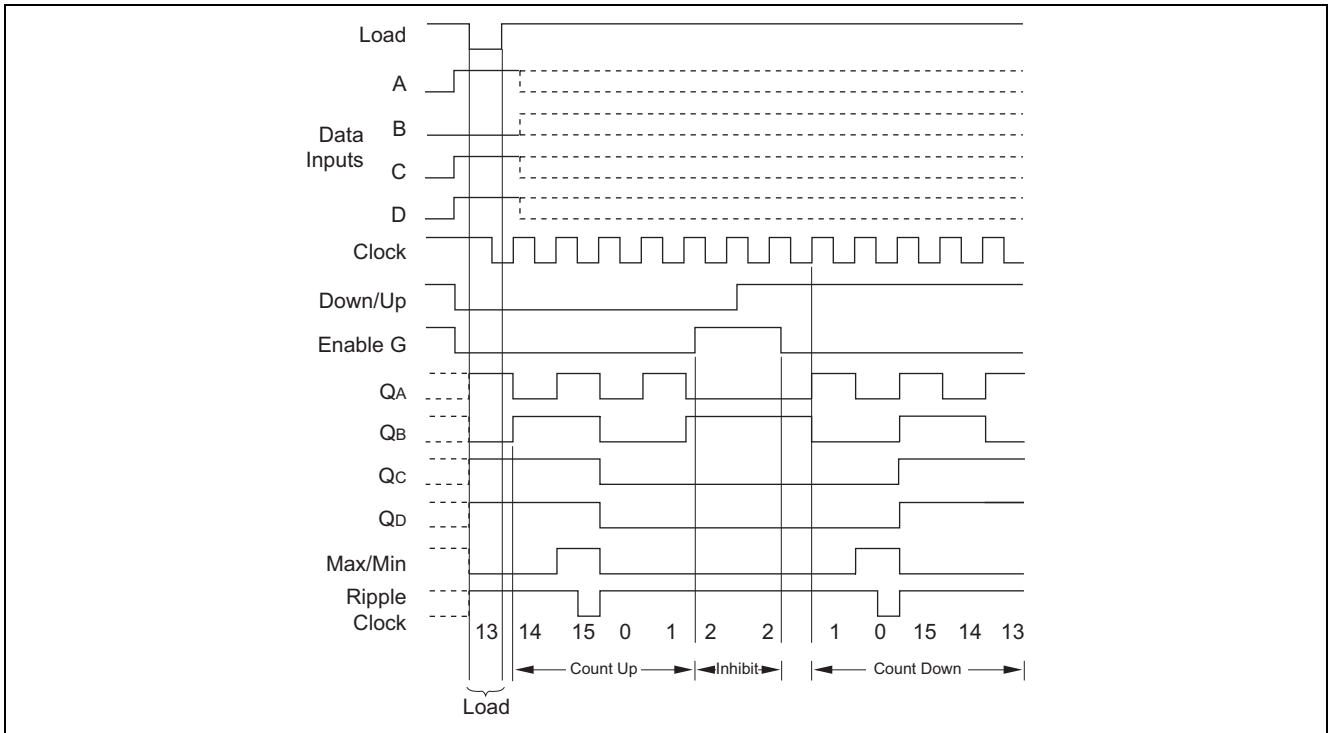


## Timing Chart

### HD74HC191

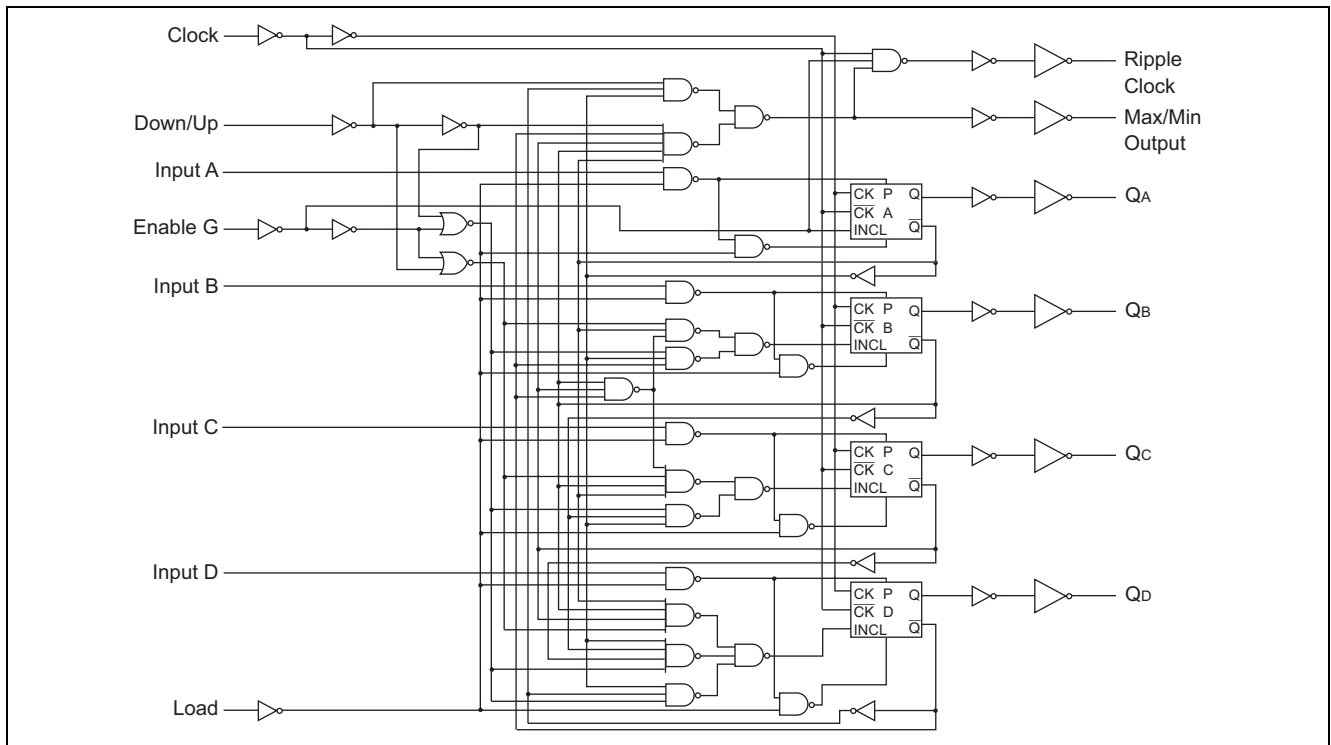
Illustrated below is the following sequence:

1. Load (preset) to binary thirteen.
2. Count up to fourteen, fifteen (maximum), zero, one and two.
3. Inhibit
4. Count down to one, zero (minimum), fifteen, fourteen and thirteen.

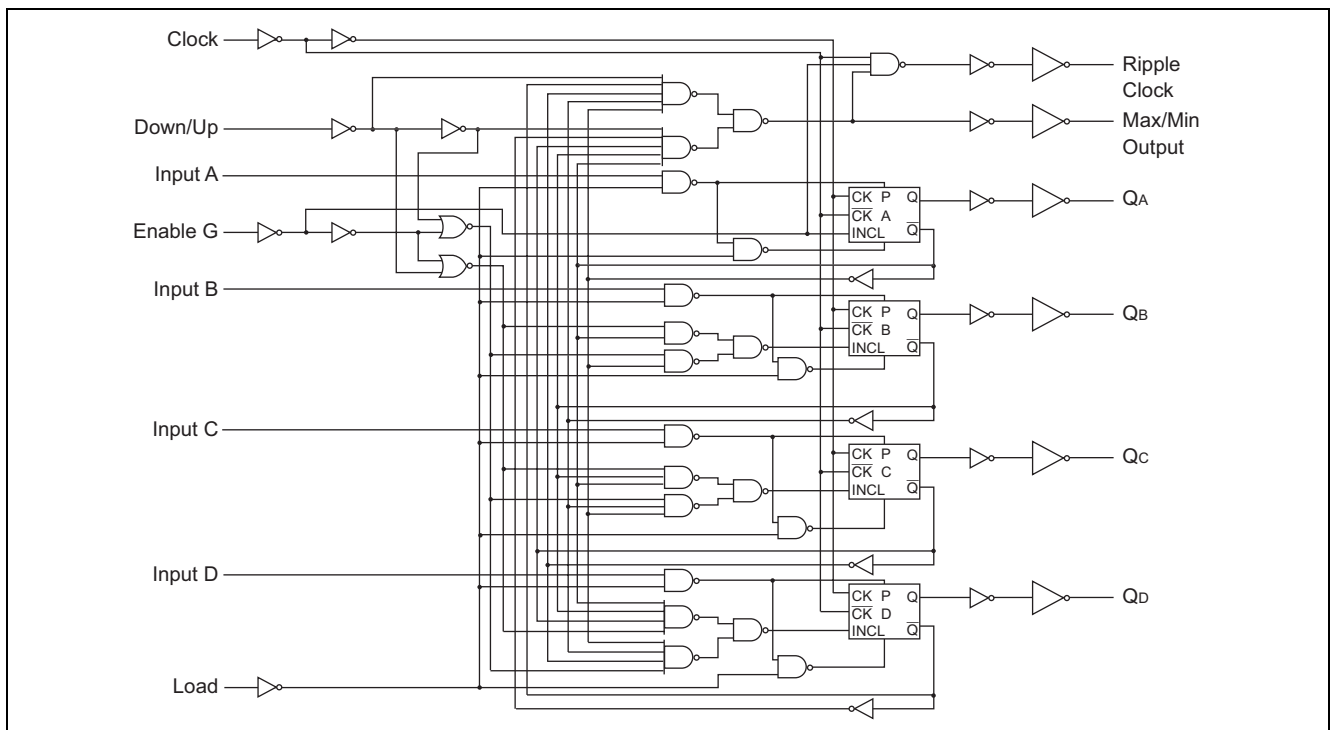


## Logic Diagram

### HD74HC190



### HD74HC191



## Absolute Maximum Ratings

| Item                         | Symbol                | Ratings                | Unit |
|------------------------------|-----------------------|------------------------|------|
| Supply voltage range         | $V_{CC}$              | -0.5 to 7.0            | V    |
| Input / Output voltage       | $V_{in}, V_{out}$     | -0.5 to $V_{CC} + 0.5$ | V    |
| Input / Output diode current | $I_{IK}, I_{OK}$      | $\pm 20$               | mA   |
| Output current               | $I_O$                 | $\pm 25$               | mA   |
| $V_{CC}$ , GND current       | $I_{CC}$ or $I_{GND}$ | $\pm 50$               | mA   |
| Power dissipation            | $P_T$                 | 500                    | mW   |
| Storage temperature          | $T_{stg}$             | -65 to +150            | °C   |

Note: The absolute maximum ratings are values, which must not individually be exceeded, and furthermore, no two of which may be realized at the same time.

## Recommended Operating Conditions

| Item                                 | Symbol            | Ratings       | Unit | Conditions       |
|--------------------------------------|-------------------|---------------|------|------------------|
| Supply voltage                       | $V_{CC}$          | 2 to 6        | V    |                  |
| Input / Output voltage               | $V_{IN}, V_{OUT}$ | 0 to $V_{CC}$ | V    |                  |
| Operating temperature                | $T_a$             | -40 to 85     | °C   |                  |
| Input rise / fall time <sup>*1</sup> | $t_r, t_f$        | 0 to 1000     | ns   | $V_{CC} = 2.0$ V |
|                                      |                   | 0 to 500      |      | $V_{CC} = 4.5$ V |
|                                      |                   | 0 to 400      |      | $V_{CC} = 6.0$ V |

Note: 1. This item guarantees maximum limit when one input switches.

Waveform: Refer to test circuit of switching characteristics.

## Electrical Characteristics

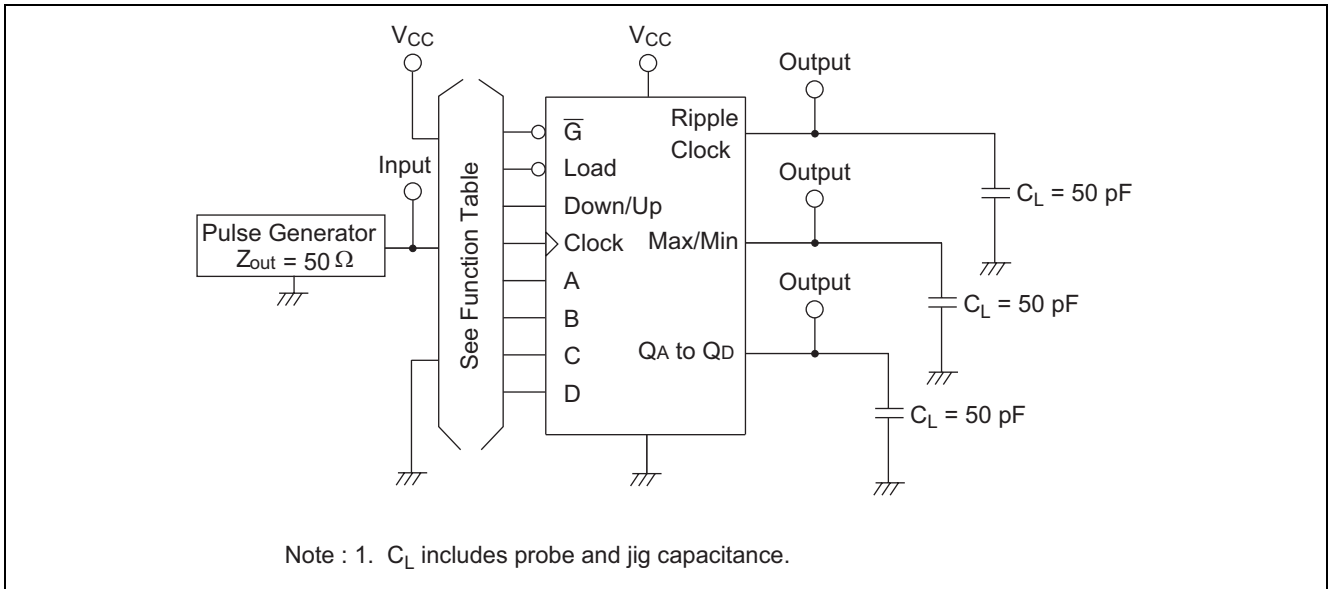
| Item                     | Symbol   | $V_{CC}$ (V) | $T_a = 25^\circ\text{C}$ |     |           | $T_a = -40 \text{ to } +85^\circ\text{C}$ |           | Unit          | Test Conditions                                           |                            |
|--------------------------|----------|--------------|--------------------------|-----|-----------|-------------------------------------------|-----------|---------------|-----------------------------------------------------------|----------------------------|
|                          |          |              | Min                      | Typ | Max       | Min                                       | Max       |               |                                                           |                            |
| Input voltage            | $V_{IH}$ | 2.0          | 1.5                      | —   | —         | 1.5                                       | —         | V             |                                                           |                            |
|                          |          | 4.5          | 3.15                     | —   | —         | 3.15                                      | —         |               |                                                           |                            |
|                          |          | 6.0          | 4.2                      | —   | —         | 4.2                                       | —         |               |                                                           |                            |
|                          | $V_{IL}$ | 2.0          | —                        | —   | 0.5       | —                                         | 0.5       | V             |                                                           |                            |
|                          |          | 4.5          | —                        | —   | 1.35      | —                                         | 1.35      |               |                                                           |                            |
|                          |          | 6.0          | —                        | —   | 1.8       | —                                         | 1.8       |               |                                                           |                            |
| Output voltage           | $V_{OH}$ | 2.0          | 1.9                      | 2.0 | —         | 1.9                                       | —         | V             | $V_{in} = V_{IH} \text{ or } V_{IL}$                      | $I_{OH} = -20 \mu\text{A}$ |
|                          |          | 4.5          | 4.4                      | 4.5 | —         | 4.4                                       | —         |               |                                                           |                            |
|                          |          | 6.0          | 5.9                      | 6.0 | —         | 5.9                                       | —         |               |                                                           |                            |
|                          |          | 4.5          | 4.18                     | —   | —         | 4.13                                      | —         |               |                                                           | $I_{OH} = -4 \text{ mA}$   |
|                          |          | 6.0          | 5.68                     | —   | —         | 5.63                                      | —         |               |                                                           | $I_{OH} = -5.2 \text{ mA}$ |
|                          | $V_{OL}$ | 2.0          | —                        | 0.0 | 0.1       | —                                         | 0.1       | V             | $V_{in} = V_{IH} \text{ or } V_{IL}$                      | $I_{OL} = 20 \mu\text{A}$  |
|                          |          | 4.5          | —                        | 0.0 | 0.1       | —                                         | 0.1       |               |                                                           |                            |
|                          |          | 6.0          | —                        | 0.0 | 0.1       | —                                         | 0.1       |               |                                                           |                            |
|                          |          | 4.5          | —                        | —   | 0.26      | —                                         | 0.33      |               |                                                           | $I_{OL} = 4 \text{ mA}$    |
|                          |          | 6.0          | —                        | —   | 0.26      | —                                         | 0.33      |               |                                                           | $I_{OL} = 5.2 \text{ mA}$  |
| Input current            | $I_{in}$ | 6.0          | —                        | —   | $\pm 0.1$ | —                                         | $\pm 1.0$ | $\mu\text{A}$ | $V_{in} = V_{CC} \text{ or GND}$                          |                            |
| Quiescent supply current | $I_{CC}$ | 6.0          | —                        | —   | 4.0       | —                                         | 40        | $\mu\text{A}$ | $V_{in} = V_{CC} \text{ or GND}, I_{out} = 0 \mu\text{A}$ |                            |

## Switching Characteristics

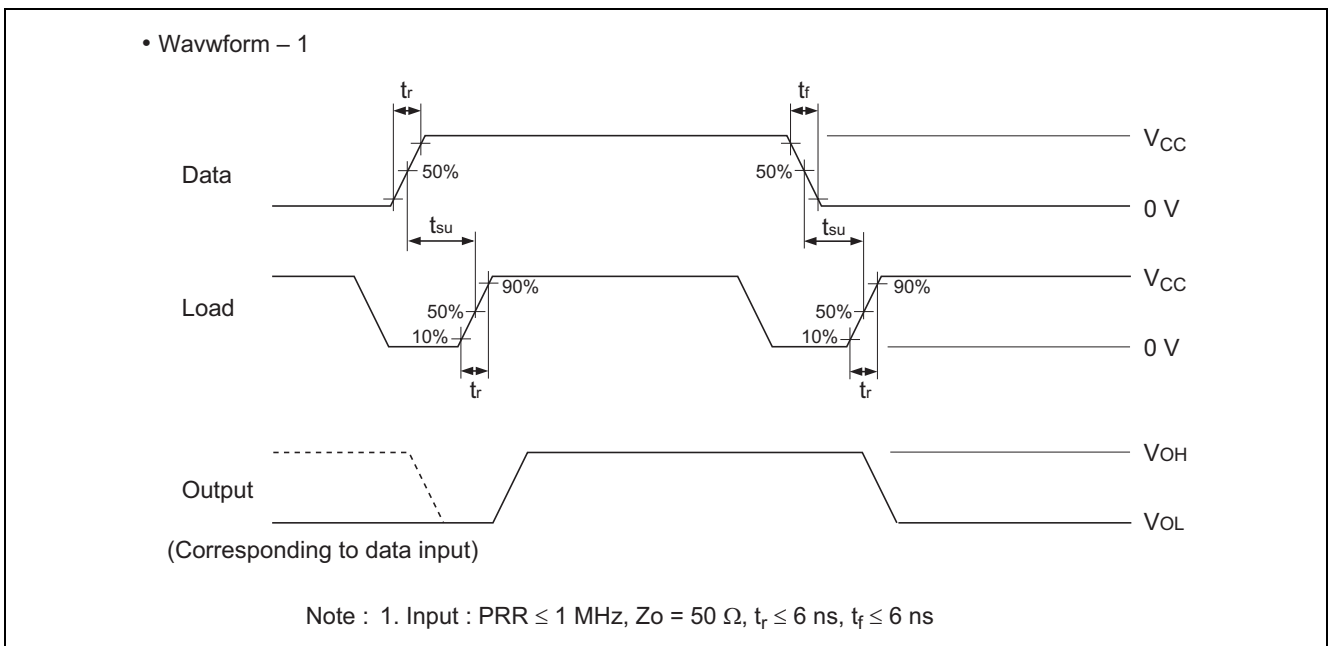
(C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6 ns)

| Item                    | Symbol                              | V <sub>CC</sub> (V) | Ta = 25°C |     |     | Ta = -40 to +85°C |     | Unit | Test Conditions    |
|-------------------------|-------------------------------------|---------------------|-----------|-----|-----|-------------------|-----|------|--------------------|
|                         |                                     |                     | Min       | Typ | Max | Min               | Max |      |                    |
| Maximum clock frequency | f <sub>max</sub>                    | 2.0                 | —         | —   | 5   | —                 | 4   | MHz  |                    |
|                         |                                     | 4.5                 | —         | —   | 25  | —                 | 20  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 29  | —                 | 24  |      |                    |
| Propagation delay time  | t <sub>PLH</sub> , t <sub>PHL</sub> | 2.0                 | —         | —   | 265 | —                 | 335 | ns   | Load to Q          |
|                         |                                     | 4.5                 | —         | 21  | 53  | —                 | 66  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 45  | —                 | 56  |      |                    |
|                         |                                     | 2.0                 | —         | —   | 230 | —                 | 290 | ns   | Data to Q          |
|                         |                                     | 4.5                 | —         | 18  | 46  | —                 | 58  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 39  | —                 | 49  |      |                    |
|                         |                                     | 2.0                 | —         | —   | 120 | —                 | 150 | ns   | Clock to RC        |
|                         |                                     | 4.5                 | —         | 14  | 24  | —                 | 30  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 20  | —                 | 26  |      |                    |
|                         |                                     | 2.0                 | —         | —   | 190 | —                 | 240 | ns   | Clock to Q         |
|                         |                                     | 4.5                 | —         | 22  | 38  | —                 | 48  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 32  | —                 | 41  |      |                    |
|                         |                                     | 2.0                 | —         | —   | 250 | —                 | 315 | ns   | Clock to max/min   |
|                         |                                     | 4.5                 | —         | 26  | 50  | —                 | 63  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 43  | —                 | 54  |      |                    |
|                         |                                     | 2.0                 | —         | —   | 230 | —                 | 290 | ns   | Down/up to RC      |
|                         |                                     | 4.5                 | —         | 20  | 46  | —                 | 58  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 39  | —                 | 49  |      |                    |
|                         |                                     | 2.0                 | —         | —   | 130 | —                 | 165 | ns   | G to RC            |
|                         |                                     | 4.5                 | —         | 14  | 26  | —                 | 33  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 22  | —                 | 28  |      |                    |
|                         |                                     | 2.0                 | —         | —   | 190 | —                 | 240 | ns   | Down/up to max/min |
|                         |                                     | 4.5                 | —         | 17  | 38  | —                 | 48  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 32  | —                 | 41  |      |                    |
| Pulse width             | t <sub>w</sub>                      | 2.0                 | 80        | —   | —   | 100               | —   | ns   |                    |
|                         |                                     | 4.5                 | 16        | 8   | —   | 20                | —   |      |                    |
|                         |                                     | 6.0                 | 14        | —   | —   | 17                | —   |      |                    |
| Hold time               | t <sub>h</sub>                      | 2.0                 | 0         | —   | —   | 0                 | —   | ns   |                    |
|                         |                                     | 4.5                 | 0         | -6  | —   | 0                 | —   |      |                    |
|                         |                                     | 6.0                 | 0         | —   | —   | 0                 | —   |      |                    |
| Setup time              | t <sub>su</sub>                     | 2.0                 | 100       | —   | —   | 125               | —   | ns   |                    |
|                         |                                     | 4.5                 | 20        | 7   | —   | 25                | —   |      |                    |
|                         |                                     | 6.0                 | 17        | —   | —   | 21                | —   |      |                    |
| Output rise/fall time   | t <sub>TLH</sub> , t <sub>THL</sub> | 2.0                 | —         | —   | 75  | —                 | 95  | ns   |                    |
|                         |                                     | 4.5                 | —         | 5   | 15  | —                 | 19  |      |                    |
|                         |                                     | 6.0                 | —         | —   | 13  | —                 | 16  |      |                    |
| Input capacitance       | C <sub>in</sub>                     | —                   | —         | 5   | 10  | —                 | 10  | pF   |                    |

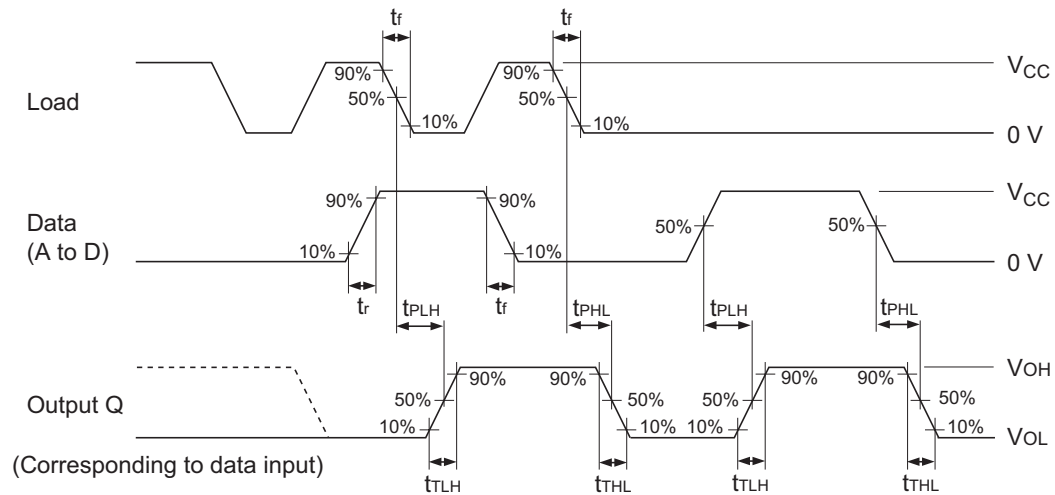
## Test Circuit



## Waveforms

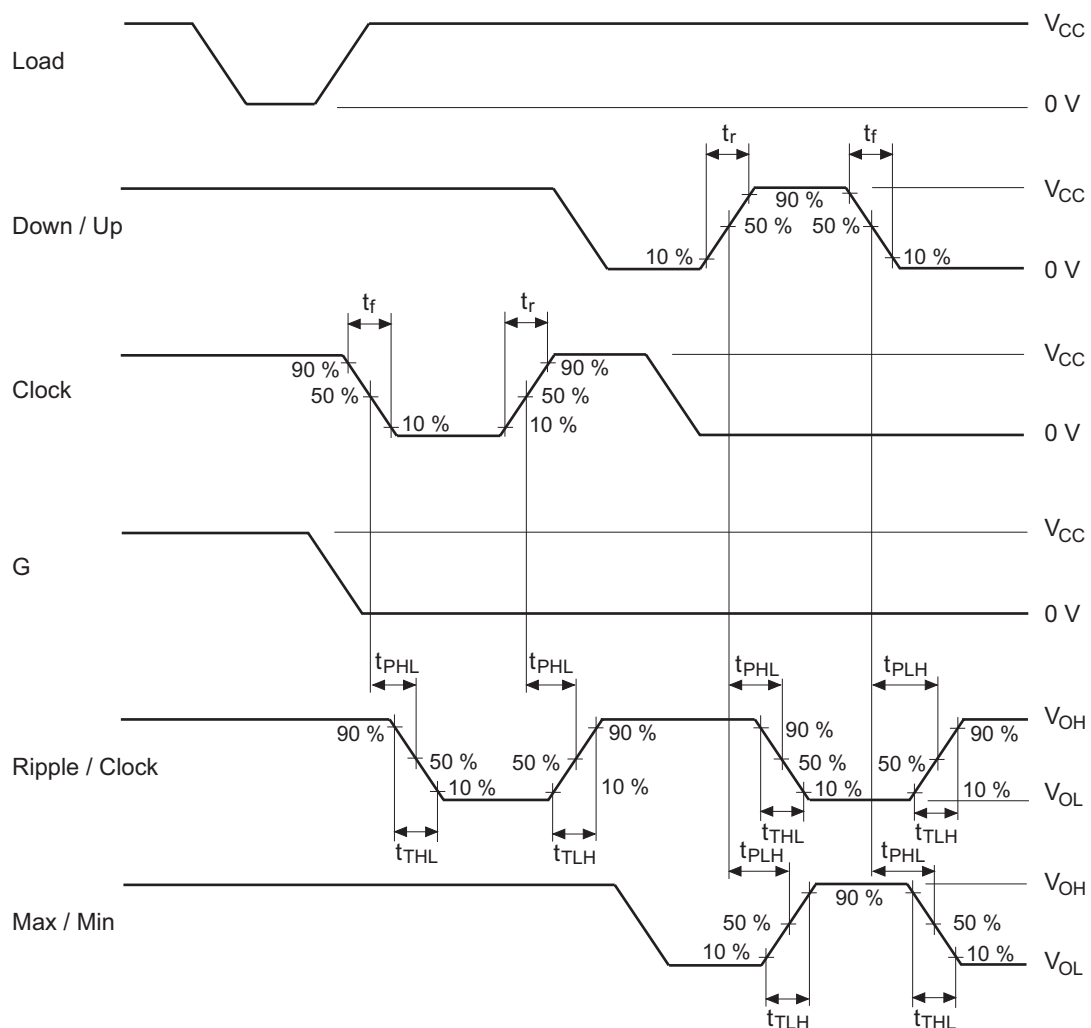


• Waveform – 2



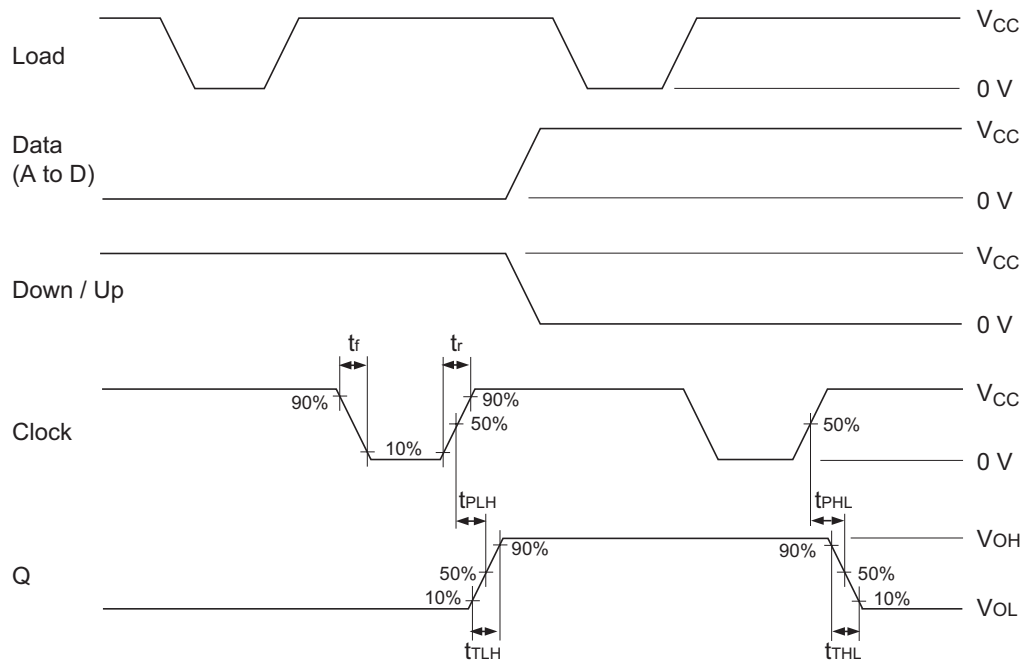
Notes : 1. Input pulse :  $PRR \leq 1 \text{ MHz}$ ,  $Z_o = 50 \Omega$ ,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$   
 2. Conditions on other inputs are  $V_{CC}$ .

• Waveform – 3



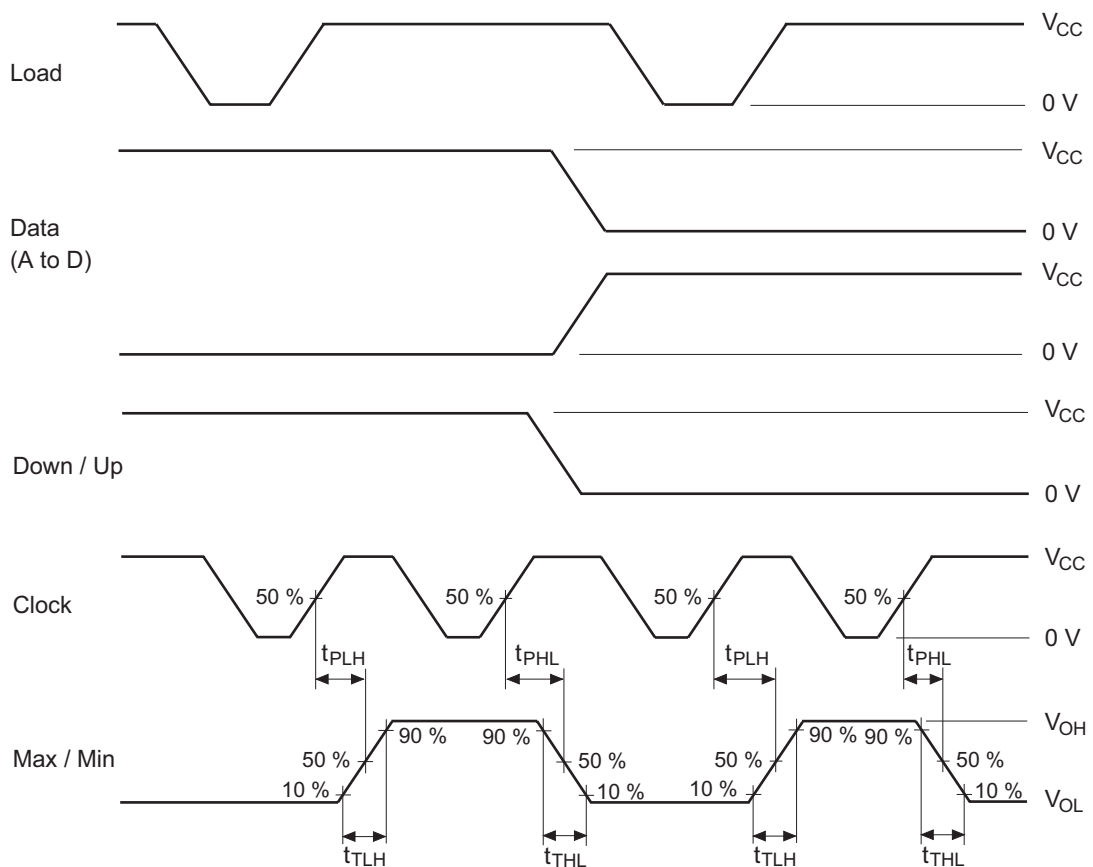
Notes : 1. Input pulse :  $PRR \leq 1 \text{ MHz}$ ,  $Z_o = 50 \Omega$ ,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$   
 2. All data inputs are GND.

• Waveform – 4



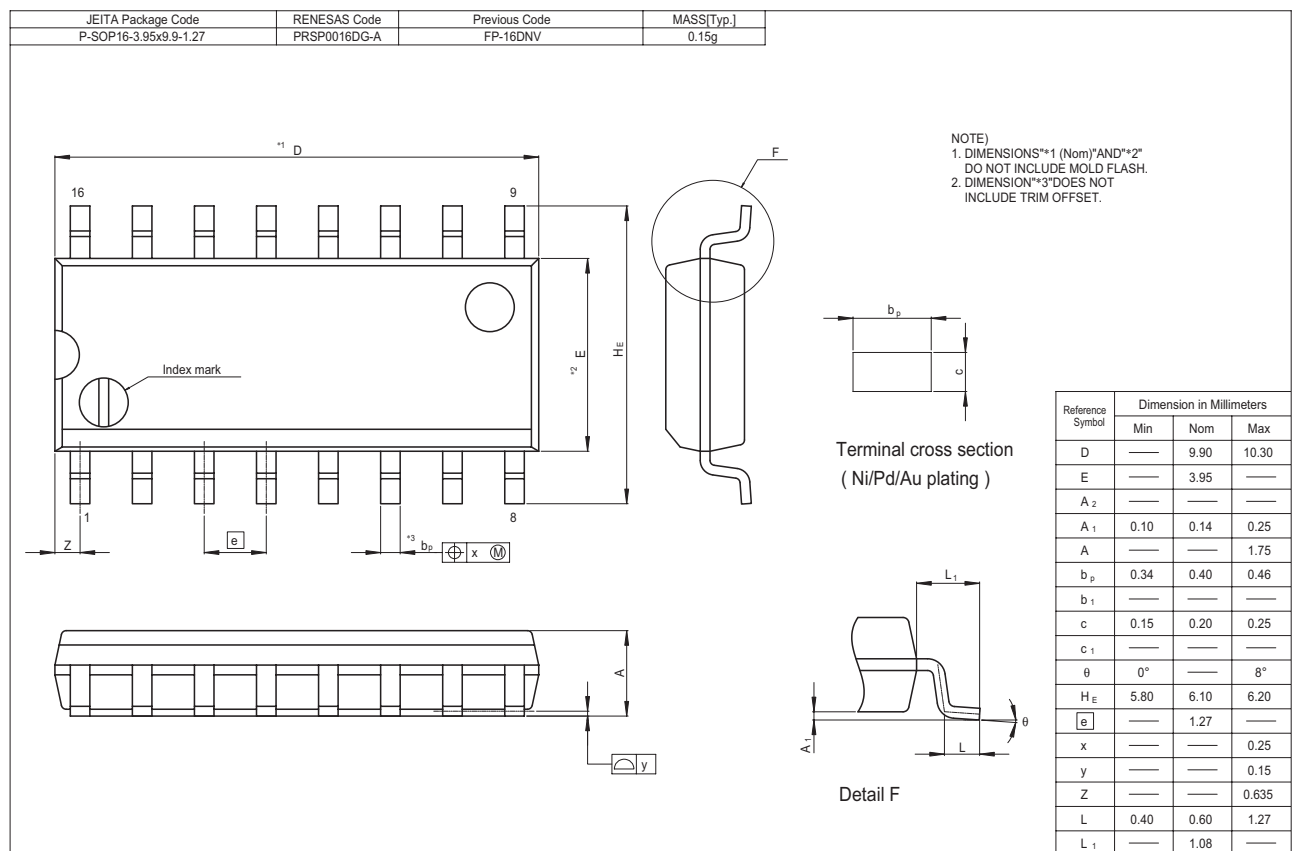
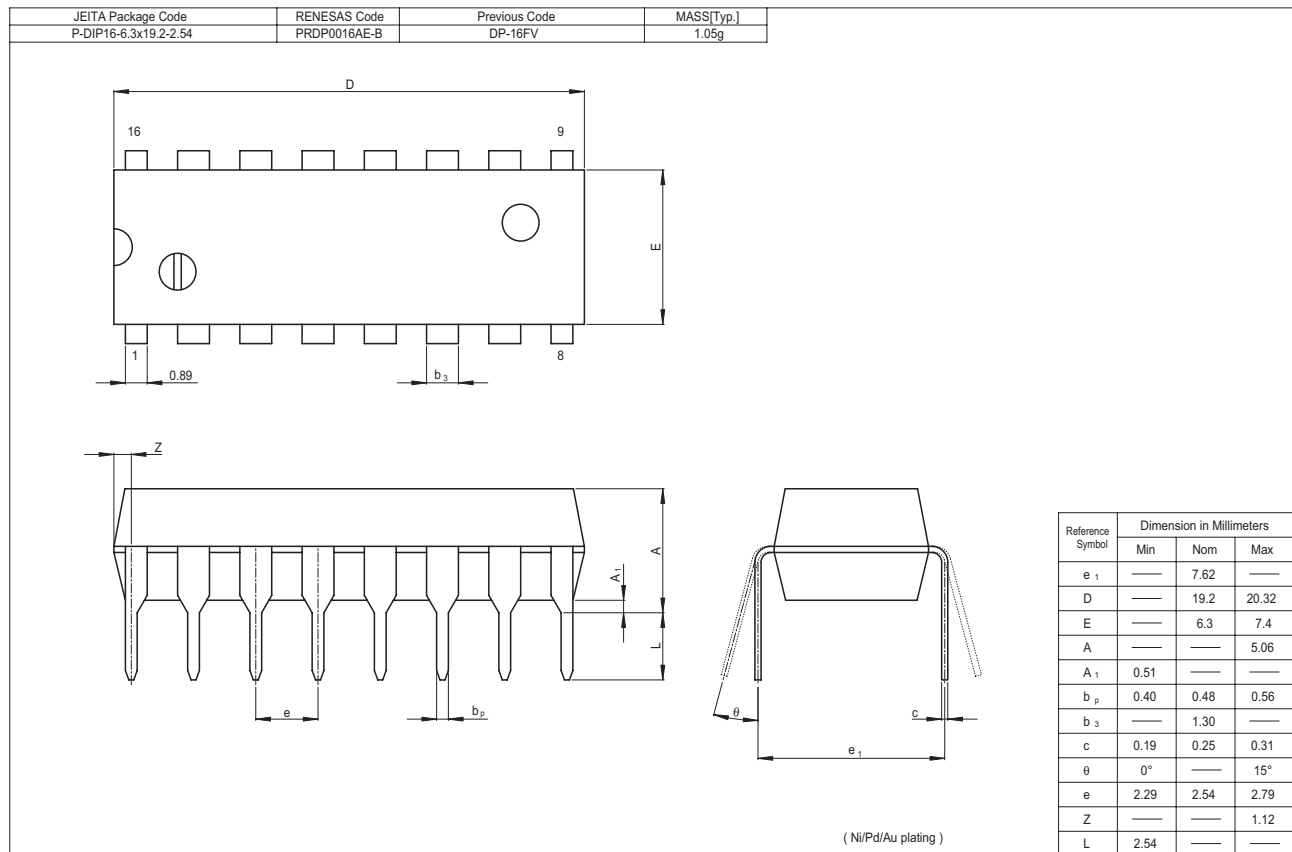
Notes : 1. Input pulse :  $PRR \leq 1 \text{ MHz}$ ,  $Z_o = 50 \Omega$ ,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$   
2. Enable = GND

• Waveform – 5

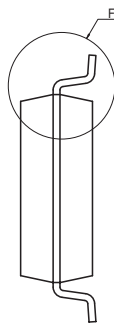
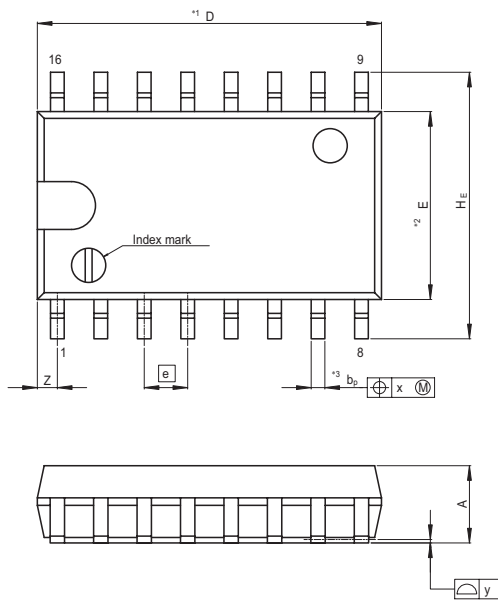


Notes : 1. Input pulse :  $PRR \leq 1 \text{ MHz}$ ,  $Z_o = 50 \Omega$ ,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$   
2. Enable = GND

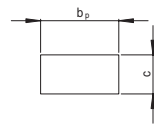
# Package Dimensions



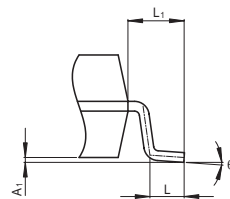
|                        |              |               |            |
|------------------------|--------------|---------------|------------|
| JEITA Package Code     | RENESAS Code | Previous Code | MASS[Typ.] |
| P-SOP16-5.5x10.06-1.27 | PRSP0016DH-B | FP-16DAV      | 0.24g      |



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



Terminal cross section  
( Ni/Pd/Au plating )



Detail F

| Reference<br>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  | —    |

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