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# HD74HC192/HD74HC193

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

## HITACHI

ADE-205-465 (Z)  
1st. Edition  
Sep. 2000

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### Description

The HD74HC192 is a decade counter, and the HD74HC193 is a binary counter. Both counters have two separate clock inputs, an up count input and a down count input. All outputs of the flip-flops are simultaneously triggered on the low to high transition of either clock while the other input is held high. The direction of counting is determined by which input is clocked.

These counters may be preset by entering the desired data on the data A, data B, data C, and data D inputs. When the load input is taken low the data is loaded independently of either clock input. This feature allows the counters to be used as divide-by-n counters by modifying the count length with the preset inputs.

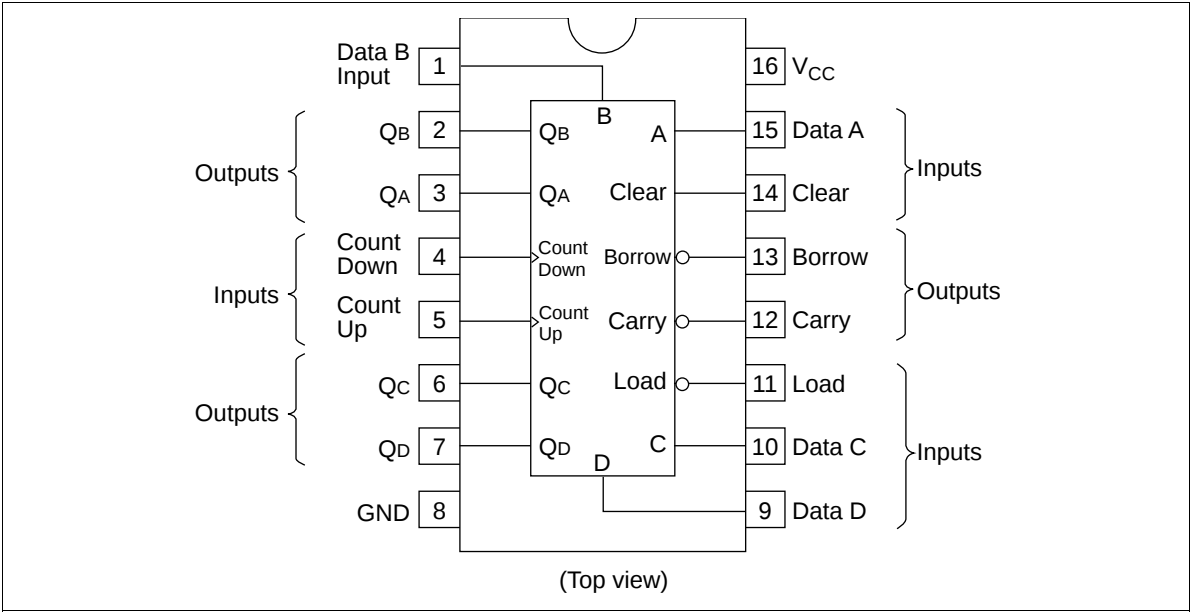
In addition both counters can also be cleared. This is accomplished by inputting a high on the clear input. All 4 internal stages are set to a low level independently of either count input.

Both a borrow and carry output are provided to enable cascading of both up and down counting functions. The borrow output produces a negative going pulse when the counter underflows and the carry outputs a pulse when the counter overflows. The counters can be cascaded by connecting the carry and borrow outputs of one device to the count up and count down inputs, respectively, of the next device.

### Features

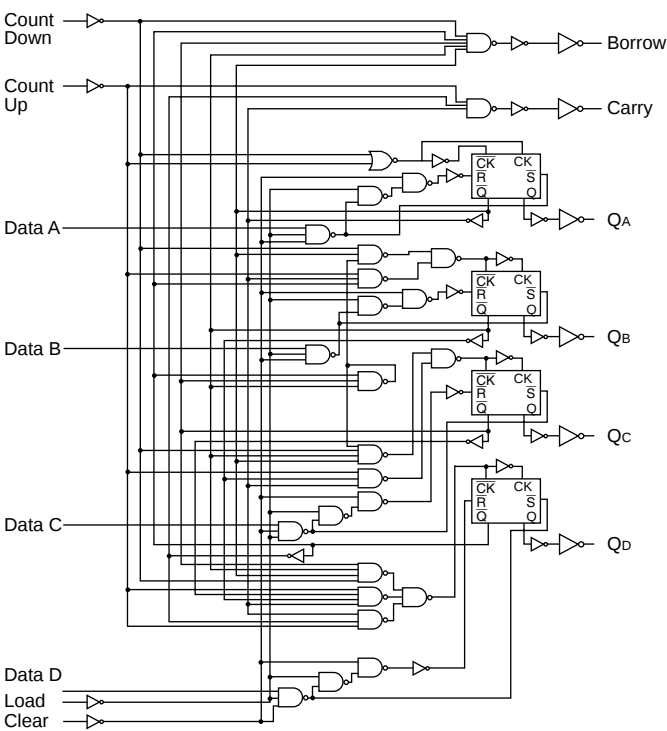
- High Speed Operation:  $t_{pd}$  (Clock Up or Count Down to Q) = 21 ns typ ( $C_L = 50$  pF)
- High Output Current: Fanout of 10 LSTTL Loads
- Wide Operating Voltage:  $V_{CC} = 2$  to 6 V
- Low Input Current: 1  $\mu$ A max
- Low Quiescent Supply Current:  $I_{CC}$  (static) = 4  $\mu$ A max ( $T_a = 25^\circ\text{C}$ )

Pin Arrangement

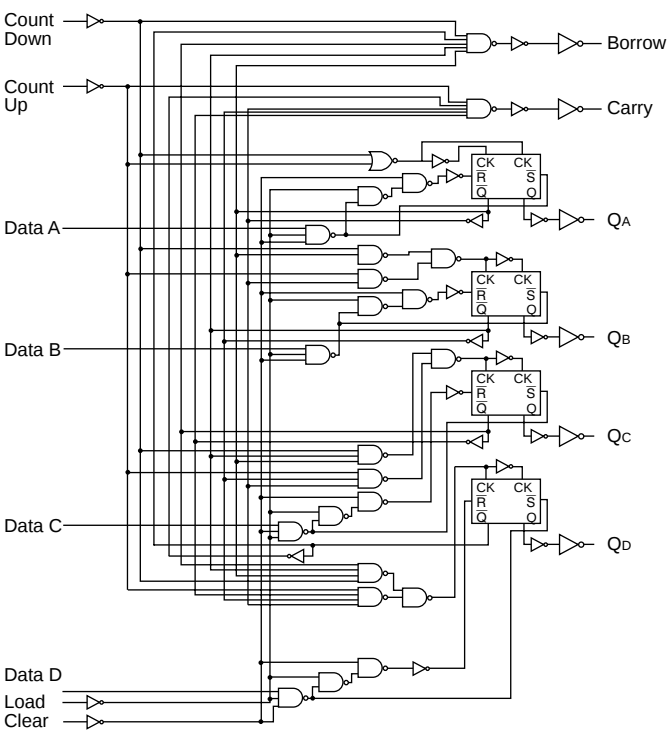


Logic Diagram

HD74HC192



HD74HC193

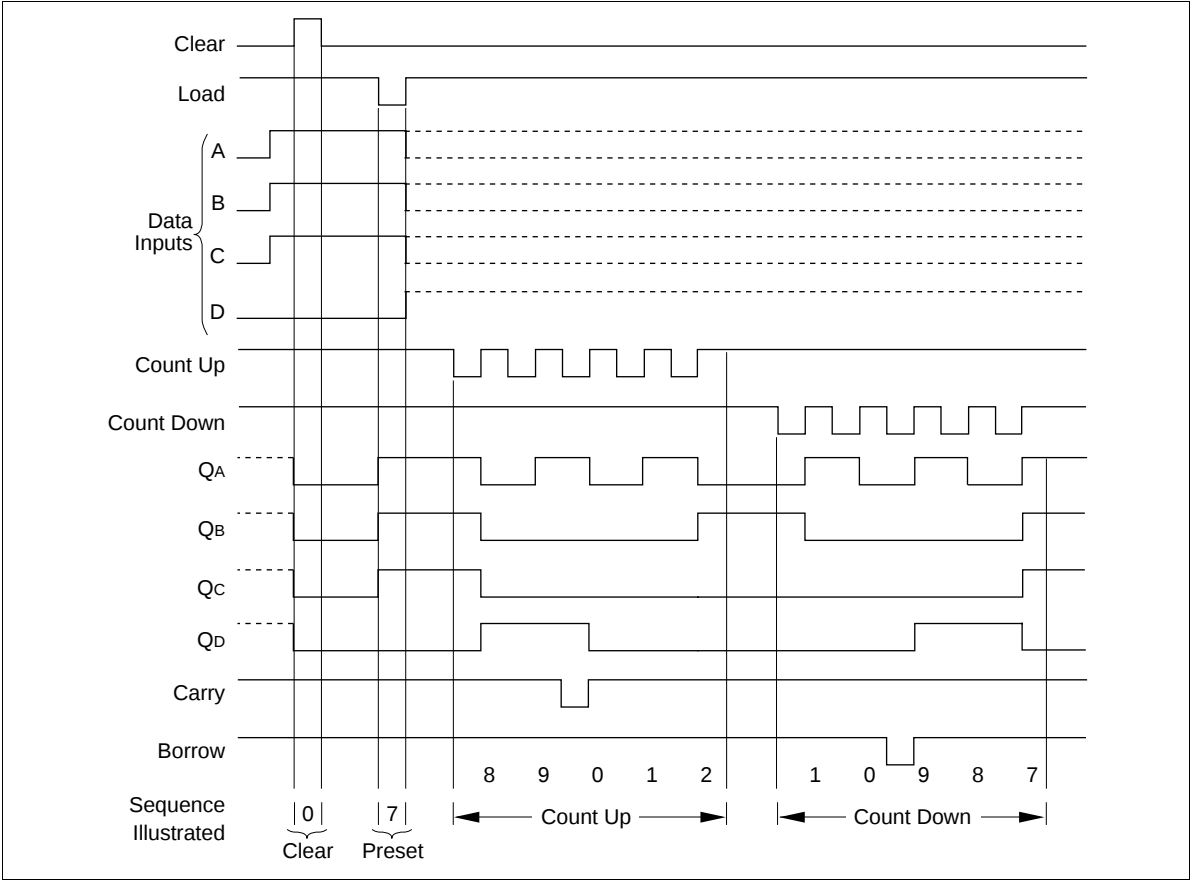


Timing Chart

HD74HC192

Illustrated below is the following sequence:

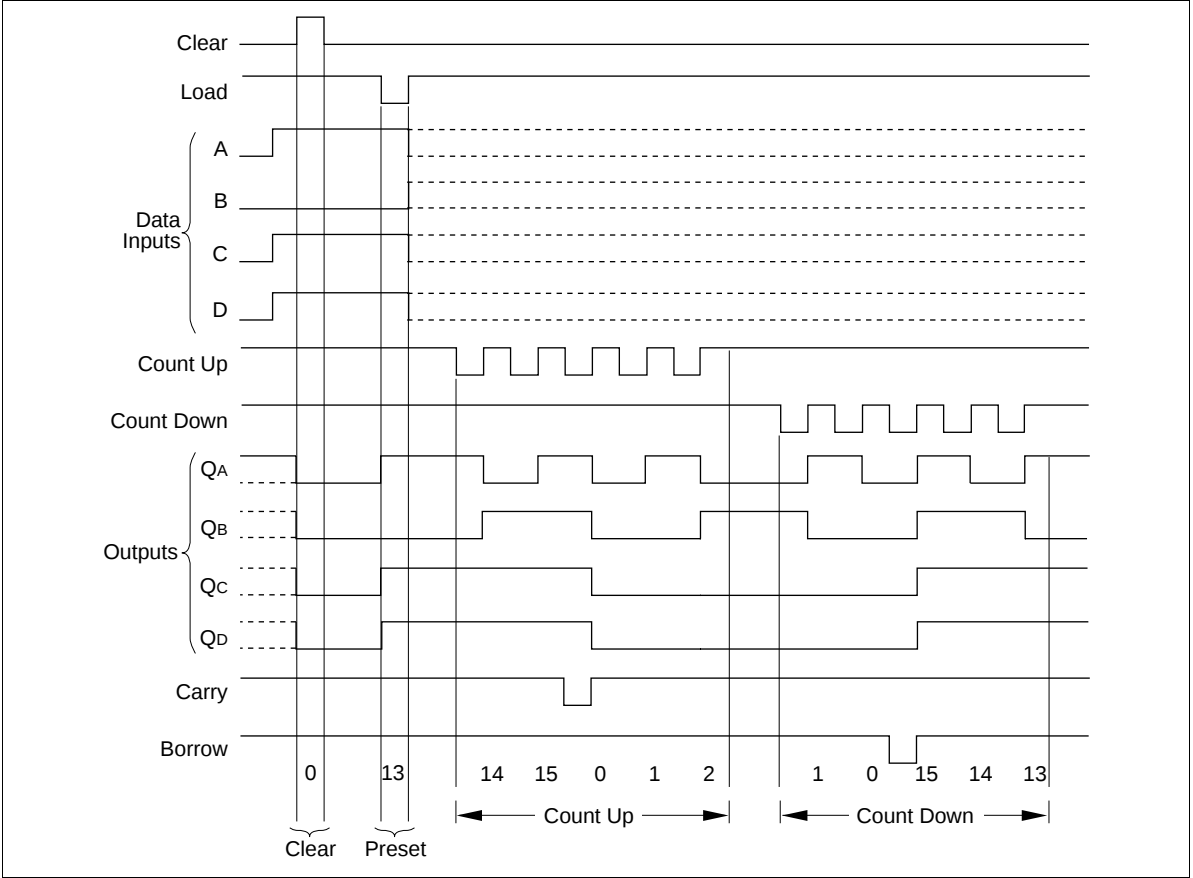
- 1. Clear outputs to zero.
- 2. Load (preset) to binary seven.
- 3. Count up to eight, nine, zero, one and two.
- 4. Count down to one, zero, borrow, nine, eight and seven.



HD74HC193

Illustrated below is the following sequence:

- 1. Clear outputs to zero.
- 2. Load (preset) to binary thirteen.
- 3. Count up to fourteen, fifteen, zero, one and two.
- 4. Count down to one, zero, borrow, fifteen and thirteen.



## 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 |
|                          | V <sub>OL</sub> | 2.0                 | —         | 0.0 | 0.1  | —                 | 0.1  | V    | Vin = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 20 µA  |                           |
|                          |                 | 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             |                           |

HD74HC192/HD74HC193

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

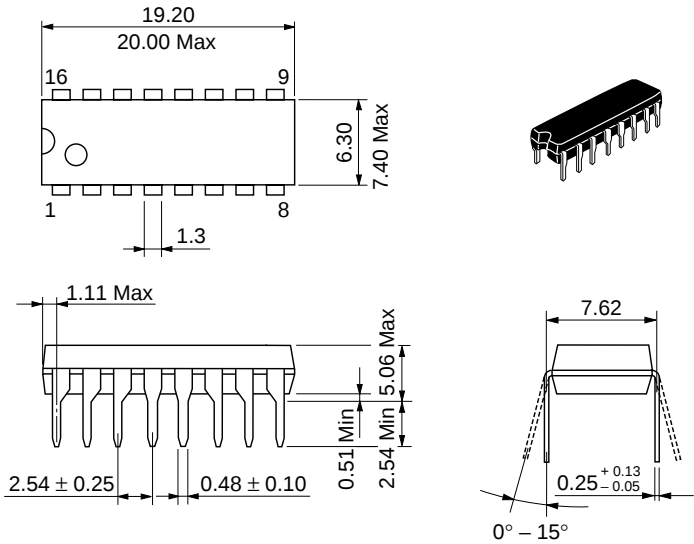
| Item                    | Symbol           | V <sub>CC</sub> (V) | Ta = 25°C |     |     | Ta = -40 to +85°C |     | Unit | Test Conditions       |
|-------------------------|------------------|---------------------|-----------|-----|-----|-------------------|-----|------|-----------------------|
|                         |                  |                     | Min       | Typ | Max | Min               | Max |      |                       |
| Maximum clock frequency | f <sub>max</sub> | 2.0                 | —         | —   | 4   | —                 | 3   | MHz  |                       |
|                         |                  | 4.5                 | —         | —   | 20  | —                 | 16  |      |                       |
|                         |                  | 6.0                 | —         | —   | 24  | —                 | 19  |      |                       |
| Propagation delay time  | t <sub>PLH</sub> | 2.0                 | —         | —   | 140 | —                 | 175 | ns   | Count up to Carry     |
|                         |                  | 4.5                 | —         | 14  | 28  | —                 | 35  |      |                       |
|                         |                  | 6.0                 | —         | —   | 24  | —                 | 30  |      |                       |
|                         | t <sub>PHL</sub> | 2.0                 | —         | —   | 130 | —                 | 165 |      |                       |
|                         |                  | 4.5                 | —         | 15  | 26  | —                 | 33  |      |                       |
|                         |                  | 6.0                 | —         | —   | 22  | —                 | 28  |      |                       |
|                         | t <sub>PLH</sub> | 2.0                 | —         | —   | 130 | —                 | 165 |      | Count down to Borrow  |
|                         |                  | 4.5                 | —         | 14  | 26  | —                 | 33  |      |                       |
|                         |                  | 6.0                 | —         | —   | 22  | —                 | 28  |      |                       |
|                         | t <sub>PHL</sub> | 2.0                 | —         | —   | 130 | —                 | 165 |      |                       |
|                         |                  | 4.5                 | —         | 15  | 26  | —                 | 33  |      |                       |
|                         |                  | 6.0                 | —         | —   | 22  | —                 | 28  |      |                       |
|                         | t <sub>PLH</sub> | 2.0                 | —         | —   | 215 | —                 | 270 |      | Count up or down to Q |
|                         |                  | 4.5                 | —         | 21  | 43  | —                 | 54  |      |                       |
|                         |                  | 6.0                 | —         | —   | 37  | —                 | 46  |      |                       |
|                         | t <sub>PHL</sub> | 2.0                 | —         | —   | 275 | —                 | 345 |      |                       |
|                         |                  | 4.5                 | —         | 21  | 55  | —                 | 69  |      |                       |
|                         |                  | 6.0                 | —         | —   | 47  | —                 | 59  |      |                       |
|                         | t <sub>PLH</sub> | 2.0                 | —         | —   | 230 | —                 | 290 |      | Load to Q             |
|                         |                  | 4.5                 | —         | 17  | 46  | —                 | 58  |      |                       |
|                         |                  | 6.0                 | —         | —   | 39  | —                 | 49  |      |                       |
|                         | t <sub>PHL</sub> | 2.0                 | —         | —   | 290 | —                 | 365 |      |                       |
|                         |                  | 4.5                 | —         | 23  | 58  | —                 | 73  |      |                       |
|                         |                  | 6.0                 | —         | —   | 49  | —                 | 62  |      |                       |
|                         | t <sub>PHL</sub> | 2.0                 | —         | —   | 265 | —                 | 335 |      | Clear to Q            |
|                         |                  | 4.5                 | —         | 24  | 53  | —                 | 66  |      |                       |
|                         |                  | 6.0                 | —         | —   | 45  | —                 | 56  |      |                       |
| Pulse width             | t <sub>w</sub>   | 2.0                 | 80        | —   | —   | 100               | —   | ns   |                       |
|                         |                  | 4.5                 | 16        | 8   | —   | 20                | —   |      |                       |
|                         |                  | 6.0                 | 14        | —   | —   | 17                | —   |      |                       |

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

| Item                  | Symbol           | V <sub>CC</sub> (V) | Ta = 25°C |     |     | Ta = -40 to +85°C |     | Unit | Test Conditions |
|-----------------------|------------------|---------------------|-----------|-----|-----|-------------------|-----|------|-----------------|
|                       |                  |                     | Min       | Typ | Max | Min               | Max |      |                 |
| Hold time             | t <sub>h</sub>   | 2.0                 | 5         | —   | —   | 5                 | —   | ns   | Data to Load    |
|                       |                  | 4.5                 | 5         | -3  | —   | 5                 | —   |      |                 |
|                       |                  | 6.0                 | 5         | —   | —   | 5                 | —   |      |                 |
| Setup time            | t <sub>su</sub>  | 2.0                 | 100       | —   | —   | 125               | —   | ns   | Data to Load    |
|                       |                  | 4.5                 | 20        | 4   | —   | 25                | —   |      |                 |
|                       |                  | 6.0                 | 17        | —   | —   | 21                | —   |      |                 |
| Removal time          | t <sub>rem</sub> | 2.0                 | 50        | —   | —   | 65                | —   | ns   | Clear to Clock  |
|                       |                  | 4.5                 | 10        | -1  | —   | 13                | —   |      |                 |
|                       |                  | 6.0                 | 9         | —   | —   | 11                | —   |      |                 |
| Output rise/fall time | t <sub>TLH</sub> | 2.0                 | —         | —   | 75  | —                 | 95  | ns   |                 |
|                       | t <sub>THL</sub> | 4.5                 | —         | 5   | 15  | —                 | 19  |      |                 |
|                       |                  | 6.0                 | —         | —   | 13  | —                 | 16  |      |                 |
| Input capacitance     | Cin              | —                   | —         | 5   | 10  | —                 | 10  | pF   |                 |

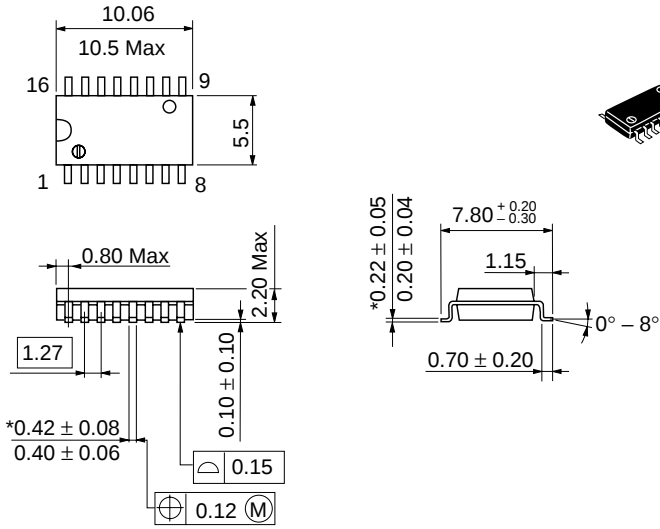
Package Dimensions

Unit: mm



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

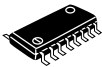
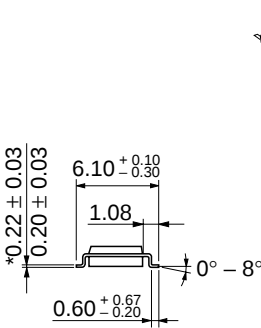
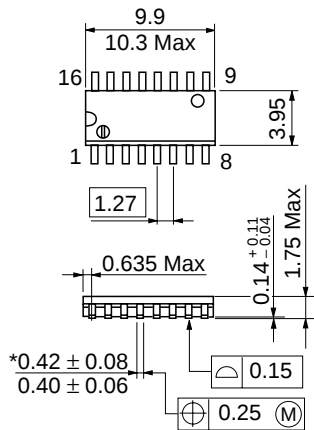
Unit: mm



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

\*Dimension including the plating thickness  
Base material dimension

Unit: mm



\*Dimension including the plating thickness  
Base material dimension

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

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