

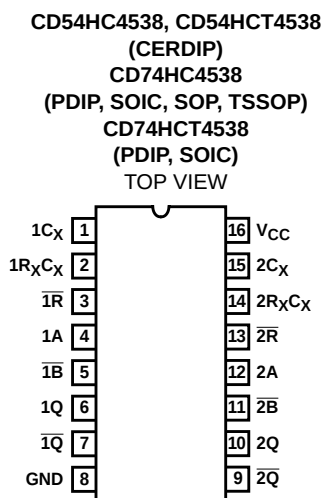
# CD54HC4538, CD74HC4538, CD54HCT4538, CD74HCT4538

## High-Speed CMOS Logic Dual Retriggerable Precision Monostable Multivibrator

### Features

- Retriggerable/Resettable Capability
- Trigger and Reset Propagation Delays Independent of  $R_X$ ,  $C_X$
- Triggering from the Leading or Trailing Edge
- Q and  $\bar{Q}$  Buffered Outputs Available
- Separate Resets
- Wide Range of Output Pulse Widths
- Schmitt Trigger Input on A and  $\bar{B}$  Inputs
- Retrigger Time is Independent of  $C_X$
- Fanout (Over Temperature Range)
  - Standard Outputs . . . . . 10 LSTTL Loads
  - Bus Driver Outputs . . . . . 15 LSTTL Loads
- Wide Operating Temperature Range . . . -55°C to 125°C
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
  - 2V to 6V Operation
  - High Noise Immunity:  $N_{IL} = 30\%$ ,  $N_{IH} = 30\%$  of  $V_{CC}$  at  $V_{CC} = 5V$
- HCT Types
  - 4.5V to 5.5V Operation
  - Direct LSTTL Input Logic Compatibility,  $V_{IL} = 0.8V$  (Max),  $V_{IH} = 2V$  (Min)
  - CMOS Input Compatibility,  $I_I \leq 1\mu A$  at  $V_{OL}$ ,  $V_{OH}$

### Pinout



### Description

The 'HC4538 and 'HCT4538 are dual retriggerable/resettable monostable precision multivibrators for fixed voltage timing applications. An external resistor ( $R_X$ ) and an external capacitor ( $C_X$ ) control the timing and the accuracy for the circuit. Adjustment of  $R_X$  and  $C_X$  provides a wide range of output pulse widths from the Q and  $\bar{Q}$  terminals. The propagation delay from trigger input-to-output transition and the propagation delay from reset input-to-output transition are independent of  $R_X$  and  $C_X$ .

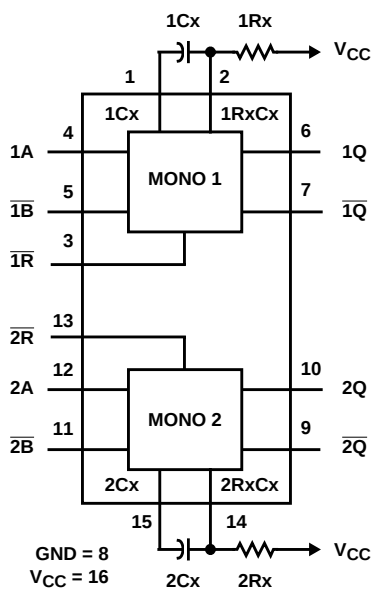
Leading-edge triggering (A) and trailing edge triggering ( $\bar{B}$ ) inputs are provided for triggering from either edge of the input pulse. An unused "A" input should be tied to GND and an unused  $\bar{B}$  should be tied to  $V_{CC}$ . On power up the IC is reset. Unused resets and sections must be terminated. In normal operation the circuit retriggers on the application of each new trigger pulse. To operate in the non-triggerable mode  $\bar{Q}$  is connected to  $\bar{B}$  when leading edge triggering (A) is used or Q is connected to A when trailing edge triggering ( $\bar{B}$ ) is used. The period ( $\tau$ ) can be calculated from  $\tau = (0.7) R_X C_X$ ;  $R_{MIN}$  is 5k $\Omega$ .  $C_{MIN}$  is 0pF.

### Ordering Information

| PART NUMBER    | TEMP. RANGE (°C) | PACKAGE      |
|----------------|------------------|--------------|
| CD54HC4538F3A  | -55 to 125       | 16 Ld CERDIP |
| CD54HCT4538F3A | -55 to 125       | 16 Ld CERDIP |
| CD74HC4538E    | -55 to 125       | 16 Ld PDIP   |
| CD74HC4538M    | -55 to 125       | 16 Ld SOIC   |
| CD74HC4538MT   | -55 to 125       | 16 Ld SOIC   |
| CD74HC4538M96  | -55 to 125       | 16 Ld SOIC   |
| CD74HC4538NSR  | -55 to 125       | 16 Ld SOP    |
| CD74HC4538PW   | -55 to 125       | 16 Ld TSSOP  |
| CD74HC4538PWR  | -55 to 125       | 16 Ld TSSOP  |
| CD74HC4538PWT  | -55 to 125       | 16 Ld TSSOP  |
| CD74HCT4538E   | -55 to 125       | 16 Ld PDIP   |
| CD74HCT4538M   | -55 to 125       | 16 Ld SOIC   |
| CD74HCT4538MT  | -55 to 125       | 16 Ld SOIC   |
| CD74HCT4538M96 | -55 to 125       | 16 Ld SOIC   |

NOTE: When ordering, use the entire part number. The suffixes 96 and R denote tape and reel. The suffix T denotes a small-quantity reel of 250.

# Functional Diagram



TRUTH TABLE

| INPUTS         |            |                | OUTPUTS   |                |
|----------------|------------|----------------|-----------|----------------|
| $\overline{R}$ | A          | $\overline{B}$ | Q         | $\overline{Q}$ |
| L              | X          | X              | L         | H              |
| X              | H          | X              | L         | H              |
| X              | X          | L              | L         | H              |
| H              | L          | $\downarrow$   | $\square$ | $\square$      |
| H              | $\uparrow$ | H              | $\square$ | $\square$      |

H = High Level, L = Low Level,  $\uparrow$  = Transition from Low to High,  
 $\downarrow$  = Transition from High to Low,  $\square$  One High Level Pulse,  
 $\square$  One Low Level Pulse, X = Irrelevant.

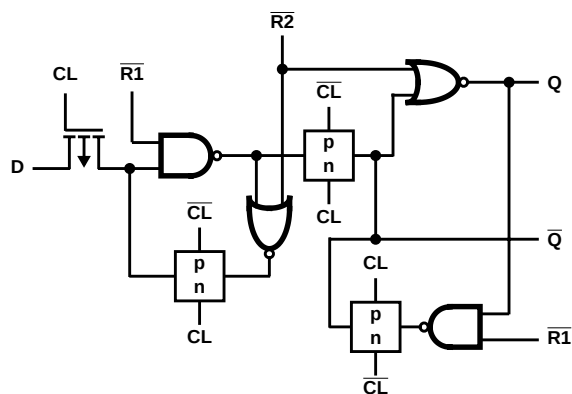


FIGURE 1. FF DETAIL

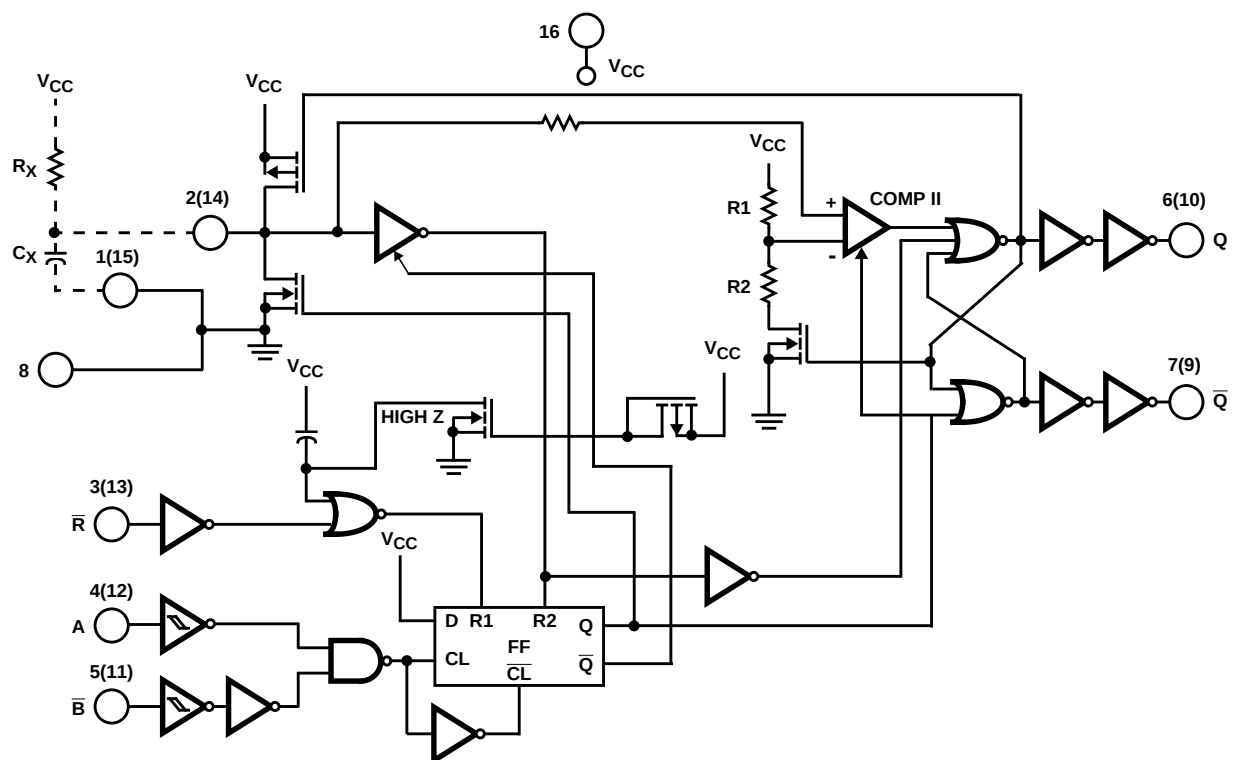


FIGURE 2. LOGIC DIAGRAM (1 MONO)

FUNCTIONAL TERMINAL CONNECTIONS

| FUNCTION                                   | V <sub>CC</sub> TO<br>TERMINAL NUMBER |                   | GND TO<br>TERMINAL NUMBER |                   | INPUT PULSE TO<br>TERMINAL NUMBER |                   | OTHER<br>CONNECTIONS |                   |
|--------------------------------------------|---------------------------------------|-------------------|---------------------------|-------------------|-----------------------------------|-------------------|----------------------|-------------------|
|                                            | MONO <sub>1</sub>                     | MONO <sub>2</sub> | MONO <sub>1</sub>         | MONO <sub>2</sub> | MONO <sub>1</sub>                 | MONO <sub>2</sub> | MONO <sub>1</sub>    | MONO <sub>2</sub> |
| Leading-Edge<br>Trigger/Retriggerable      | 3, 5                                  | 11, 13            |                           |                   | 4                                 | 12                |                      |                   |
| Leading-Edge<br>Trigger/Non-Retriggerable  | 3                                     | 13                |                           |                   | 4                                 | 12                | 5-7                  | 11-9              |
| Trailing-Edge<br>Trigger/Retriggerable     | 3                                     | 13                | 4                         | 12                | 5                                 | 11                |                      |                   |
| Trailing-Edge<br>Trigger/Non-Retriggerable | 3                                     | 13                |                           |                   | 5                                 | 11                | 4-6                  | 12-10             |

NOTES:

1. A retriggerable one-shot multivibrator has an output pulse width which is extended one full time period (T) after application of the last trigger pulse.
2. A non-triggerable one-shot multivibrator has a time period (T) referenced from the application of the first trigger pulse.



FIGURE 3. INPUT PULSE TRAIN

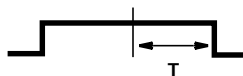


FIGURE 4. RETRIGGERABLE MODE  
PULSE WIDTH (A MODE)

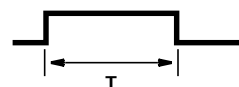


FIGURE 5. NON-RETRIGGERABLE MODE  
PULSE WIDTH  
(A MODE)

# CD54HC4538, CD74HC4538, CD54HCT4538, CD74HCT4538

## Absolute Maximum Ratings

|                                                        |             |
|--------------------------------------------------------|-------------|
| DC Supply Voltage, $V_{CC}$                            | -0.5V to 7V |
| DC Input Diode Current, $I_{IK}$                       |             |
| For $V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$             | $\pm 20mA$  |
| DC Output Diode Current, $I_{OK}$                      |             |
| For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$             | $\pm 20mA$  |
| DC Output Source or Sink Current per Output Pin, $I_O$ |             |
| For $V_O > -0.5V$ or $V_O < V_{CC} + 0.5V$             | $\pm 25mA$  |
| DC $V_{CC}$ or Ground Current, $I_{CC}$                | $\pm 50mA$  |

## Operating Conditions

|                                           |                    |
|-------------------------------------------|--------------------|
| Temperature Range, $T_A$                  | -55°C to 125°C     |
| Supply Voltage Range, $V_{CC}$ (Note 3)   |                    |
| HC Types                                  | .2V to 6V          |
| HCT Types                                 | 4.5V to 5.5V       |
| DC Input or Output Voltage, $V_I$ , $V_O$ | 0V to $V_{CC}$     |
| Input Rise and Fall Times, $t_r$ , $t_f$  |                    |
| Reset Input:                              |                    |
| 2V                                        | 1000ns (Max)       |
| 4.5V                                      | 500ns (Max)        |
| 6V                                        | 400ns (Max)        |
| Trigger Inputs A or B:                    |                    |
| 2V                                        | Unlimited (Max)    |
| 4.5V                                      | Unlimited (Max)    |
| 6V                                        | Unlimited (Max)    |
| External Timing Resistor, $R_X$ (Note 4)  | .5k $\Omega$ (Min) |
| External Timing Capacitor, $C_X$ (Note 4) | 0 (Min)            |

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

## NOTES:

- Unless otherwise specified, all voltages are referenced to ground.
- The maximum allowable values of  $R_X$  and  $C_X$  are a function of leakage of capacitor  $C_X$ , the leakage of the 'HC4538, and leakage due to board layout and surface resistance. Values of  $R_X$  and  $C_X$  should be chosen so that the maximum current into pin 2 or pin 14 is 30mA. Susceptibility to externally induced noise signals may occur for  $R_X > 1M\Omega$ .
- The package thermal impedance is calculated in accordance with JESD 51-7.

## DC Electrical Specifications

| PARAMETER                               | SYMBOL          | TEST CONDITIONS                    |                     | V <sub>CC</sub> (V) | 25°C |     |      | -40°C TO 85°C |      | -55°C TO 125°C |      | UNITS |
|-----------------------------------------|-----------------|------------------------------------|---------------------|---------------------|------|-----|------|---------------|------|----------------|------|-------|
|                                         |                 | V <sub>I</sub> (V)                 | I <sub>O</sub> (mA) |                     | MIN  | TYP | MAX  | MIN           | MAX  | MIN            | MAX  |       |
| HC TYPES                                |                 |                                    |                     |                     |      |     |      |               |      |                |      |       |
| High Level Input Voltage                | V <sub>IH</sub> | -                                  | -                   | 2                   | 1.5  | -   | -    | 1.5           | -    | 1.5            | -    | V     |
|                                         |                 |                                    |                     | 4.5                 | 3.15 | -   | -    | 3.15          | -    | 3.15           | -    | V     |
|                                         |                 |                                    |                     | 6                   | 4.2  | -   | -    | 4.2           | -    | 4.2            | -    | V     |
| Low Level Input Voltage                 | V <sub>IL</sub> | -                                  | -                   | 2                   | -    | -   | 0.5  | -             | 0.5  | -              | 0.5  | V     |
|                                         |                 |                                    |                     | 4.5                 | -    | -   | 1.35 | -             | 1.35 | -              | 1.35 | V     |
|                                         |                 |                                    |                     | 6                   | -    | -   | 1.8  | -             | 1.8  | -              | 1.8  | V     |
| High Level Output Voltage<br>CMOS Loads | V <sub>OH</sub> | V <sub>IH</sub> or V <sub>IL</sub> | -0.02               | 2                   | 1.9  | -   | -    | 1.9           | -    | 1.9            | -    | V     |
|                                         |                 |                                    | -0.02               | 4.5                 | 4.4  | -   | -    | 4.4           | -    | 4.4            | -    | V     |
|                                         |                 |                                    | -0.02               | 6                   | 5.9  | -   | -    | 5.9           | -    | 5.9            | -    | V     |
| High Level Output Voltage<br>TTL Loads  |                 |                                    | -                   | -                   | -    | -   | -    | -             | -    | -              | -    | V     |
|                                         |                 |                                    | -4                  | 4.5                 | 3.98 | -   | -    | 3.84          | -    | 3.7            | -    | V     |
|                                         |                 |                                    | -5.2                | 6                   | 5.48 | -   | -    | 5.34          | -    | 5.2            | -    | V     |

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**DC Electrical Specifications (Continued)**

| PARAMETER                                                               | SYMBOL                       | TEST CONDITIONS                    |                     | V <sub>CC</sub> (V) | 25°C |     |       | -40°C TO 85°C |      | -55°C TO 125°C |      | UNITS |
|-------------------------------------------------------------------------|------------------------------|------------------------------------|---------------------|---------------------|------|-----|-------|---------------|------|----------------|------|-------|
|                                                                         |                              | V <sub>I</sub> (V)                 | I <sub>O</sub> (mA) |                     | MIN  | TYP | MAX   | MIN           | MAX  | MIN            | MAX  |       |
| Low Level Output Voltage<br>CMOS Loads                                  | V <sub>OL</sub>              | V <sub>IH</sub> or V <sub>IL</sub> | 0.02                | 2                   | -    | -   | 0.1   | -             | 0.1  | -              | 0.1  | V     |
|                                                                         |                              |                                    | 0.02                | 4.5                 | -    | -   | 0.1   | -             | 0.1  | -              | 0.1  | V     |
|                                                                         |                              |                                    | 0.02                | 6                   | -    | -   | 0.1   | -             | 0.1  | -              | 0.1  | V     |
| Low Level Output Voltage<br>TTL Loads                                   |                              |                                    | -                   | -                   | -    | -   | -     | -             | -    | -              | -    | V     |
|                                                                         |                              |                                    | 4                   | 4.5                 | -    | -   | 0.26  | -             | 0.33 | -              | 0.4  | V     |
|                                                                         |                              |                                    | 5.2                 | 6                   | -    | -   | 0.26  | -             | 0.33 | -              | 0.4  | V     |
| Input Leakage Current A, B, R                                           | I <sub>I</sub>               | V <sub>CC</sub> or GND             | -                   | 6                   | -    | -   | ±0.1  | -             | ±1   | -              | ±1   | μA    |
| Input Leakage Current R <sub>X</sub> C <sub>X</sub><br>(Note 6)         |                              |                                    | -                   | 6                   | -    | -   | ±0.05 | -             | ±0.5 | -              | ±0.5 | μA    |
| Quiescent Device Current                                                | I <sub>CC</sub>              | V <sub>CC</sub> or GND             | 0                   | 6                   | -    | -   | 8     | -             | 80   | -              | 160  | μA    |
| Active Device Current<br>Q = High & Pins 2, 14<br>at V <sub>CC</sub> /4 | I <sub>CC</sub>              | V <sub>CC</sub> or GND             | 0                   | 6                   | -    | -   | 0.6   | -             | 0.8  | -              | 1    | mA    |
| <b>HCT TYPES</b>                                                        |                              |                                    |                     |                     |      |     |       |               |      |                |      |       |
| High Level Input Voltage                                                | V <sub>IH</sub>              | -                                  | -                   | 4.5 to 5.5          | 2    | -   | -     | 2             | -    | 2              | -    | V     |
| Low Level Input Voltage                                                 | V <sub>IL</sub>              | -                                  | -                   | 4.5 to 5.5          | -    | -   | 0.8   | -             | 0.8  | -              | 0.8  | V     |
| High Level Output Voltage<br>CMOS Loads                                 | V <sub>OH</sub>              | V <sub>IH</sub> or V <sub>IL</sub> | -0.02               | 4.5                 | 4.4  | -   | -     | 4.4           | -    | 4.4            | -    | V     |
| High Level Output Voltage<br>TTL Loads                                  |                              |                                    | -4                  | 4.5                 | 3.98 | -   | -     | 3.84          | -    | 3.7            | -    | V     |
| Low Level Output Voltage<br>CMOS Loads                                  | V <sub>OL</sub>              | V <sub>IH</sub> or V <sub>IL</sub> | 0.02                | 4.5                 | -    | -   | 0.1   | -             | 0.1  | -              | 0.1  | V     |
| Low Level Output Voltage<br>TTL Loads                                   |                              |                                    | 4                   | 4.5                 | -    | -   | 0.26  | -             | 0.33 | -              | 0.4  | V     |
| Input Leakage Current                                                   | I <sub>I</sub>               | V <sub>CC</sub> and GND            | -                   | 5.5                 | -    | -   | ±0.1  | -             | ±1   | -              | ±1   | μA    |
| Input Leakage Current R <sub>X</sub> C <sub>X</sub><br>(Note 6)         |                              |                                    | -                   | 5.5                 | -    | -   | ±0.05 | -             | ±0.5 | -              | ±0.5 | μA    |
| Quiescent Device Current                                                | I <sub>CC</sub>              | V <sub>CC</sub> or GND             | 0                   | 5.5                 | -    | -   | 8     | -             | 80   | -              | 160  | μA    |
| Active Device Current<br>Q = High & Pins 2, 14<br>at V <sub>CC</sub> /4 | I <sub>CC</sub>              | V <sub>CC</sub> or GND             | 0                   | 5.5                 | -    | -   | 0.6   | -             | 0.8  | -              | 1    | mA    |
| Additional Quiescent Device Current Per<br>Input Pin: 1 Unit Load       | ΔI <sub>CC</sub><br>(Note 7) | V <sub>CC</sub><br>-2.1            | -                   | 4.5 to 5.5          | -    | 100 | 360   | -             | 450  | -              | 490  | μA    |

**NOTES:**

- When testing I<sub>IL</sub> the Q output must be high. If Q is low (device not triggered) the pull-up P device will be ON and the low resistance path from V<sub>DD</sub> to the test pin will cause a current far exceeding the specification.
- For dual-supply systems theoretical worst case (V<sub>I</sub> = 2.4V, V<sub>CC</sub> = 5.5V) specification is 1.8mA.

**CD54HC4538, CD74HC4538, CD54HCT4538, CD74HCT4538**

**HCT Input Loading Table**

| INPUT | UNIT LOADS |
|-------|------------|
| All   | 0.5        |

NOTE: Unit Load is  $\Delta I_{CC}$  limit specified in DC Electrical Table, e.g. 360 $\mu$ A max at 25°C.

**Prerequisite for Switching Specifications**

| PARAMETER                               | SYMBOL           | V <sub>CC</sub> (V) | 25°C     |     |     | -40°C TO 85°C |     |     | -55°C TO 125°C |     |     | UNITS |
|-----------------------------------------|------------------|---------------------|----------|-----|-----|---------------|-----|-----|----------------|-----|-----|-------|
|                                         |                  |                     | MIN      | TYP | MAX | MIN           | TYP | MAX | MIN            | TYP | MAX |       |
| HC TYPES                                |                  |                     |          |     |     |               |     |     |                |     |     |       |
| Input Pulse Widths<br>A, $\overline{B}$ | $t_{WH}, t_{WL}$ | 2                   | 80       | -   | -   | 100           | -   | -   | 120            | -   | -   | ns    |
|                                         |                  | 4.5                 | 16       | -   | -   | 20            | -   | -   | 24             | -   | -   | ns    |
|                                         |                  | 6                   | 14       | -   | -   | 17            | -   | -   | 20             | -   | -   | ns    |
| $\overline{R}$                          | $t_{WL}$         | 2                   | 80       | -   | -   | 100           | -   | -   | 120            | -   | -   | ns    |
|                                         |                  | 4.5                 | 16       | -   | -   | 20            | -   | -   | 24             | -   | -   | ns    |
|                                         |                  | 6                   | 14       | -   | -   | 17            | -   | -   | 20             | -   | -   | ns    |
| Reset Recovery Time                     | $t_{REC}$        | 2                   | 5        | -   | -   | 5             | -   | -   | 5              | -   | -   | ns    |
|                                         |                  | 4.5                 | 5        | -   | -   | 5             | -   | -   | 5              | -   | -   | ns    |
|                                         |                  | 6                   | 5        | -   | -   | 5             | -   | -   | 5              | -   | -   | ns    |
| Retrigger Time<br>(Figure 11)           | $t_{rT}$         | 5                   | -        | 175 | -   | -             | -   | -   | -              | -   | -   | ns    |
| HCT TYPES                               |                  |                     |          |     |     |               |     |     |                |     |     |       |
| Input Pulse Widths<br>A, $\overline{B}$ | $t_{WH}, t_{WL}$ | 4.5                 | 16       | -   | -   | 20            | -   | -   | 24             | -   | -   | ns    |
|                                         |                  | $\overline{R}$      | $t_{WL}$ | 4.5 | 20  | -             | -   | 25  | -              | -   | 30  | -     |
| Reset Recovery Time                     | $t_{REC}$        | 4.5                 | 5        | -   | -   | 5             | -   | -   | 5              | -   | -   | ns    |
| Retrigger Time<br>(Figure 11)           | $t_{rT}$         | 5                   | -        | 175 | -   | -             | -   | -   | -              | -   | -   | ns    |

**CD54HC4538, CD74HC4538, CD54HCT4538, CD74HCT4538**

**Switching Specifications**  $C_L = 50\text{pF}$ , Input  $t_r, t_f = 6\text{ns}$ ,  $R_X = 10\text{k}\Omega$ ,  $C_X = 0$

| PARAMETER                                                          | SYMBOL                              | TEST CONDITIONS       | V <sub>CC</sub> (V) | 25°C |     |      | -40°C TO 85°C |       | -55°C TO 125°C |       | UNITS |
|--------------------------------------------------------------------|-------------------------------------|-----------------------|---------------------|------|-----|------|---------------|-------|----------------|-------|-------|
|                                                                    |                                     |                       |                     | MIN  | TYP | MAX  | MIN           | MAX   | MIN            | MAX   |       |
| HC TYPES                                                           |                                     |                       |                     |      |     |      |               |       |                |       |       |
| Propagation Delay<br>A, $\overline{B}$ to Q                        | t <sub>PLH</sub>                    | C <sub>L</sub> = 50pF | 2                   | -    | -   | 250  | -             | 315   | -              | 375   | ns    |
|                                                                    |                                     |                       | 4.5                 | -    | -   | 50   | -             | 63    | -              | 75    | ns    |
|                                                                    |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 21  | -    | -             | -     | -              | -     | ns    |
|                                                                    |                                     | C <sub>L</sub> = 50pF | 6                   | -    | -   | 43   | -             | 54    | -              | 64    | ns    |
| A, $\overline{B}$ to $\overline{Q}$                                | t <sub>PHL</sub>                    | C <sub>L</sub> = 50pF | 2                   | -    | -   | 250  | -             | 315   | -              | 375   | ns    |
|                                                                    |                                     |                       | 4.5                 | -    | -   | 50   | -             | 63    | -              | 75    | ns    |
|                                                                    |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 21  | -    | -             | -     | -              | -     | ns    |
|                                                                    |                                     | C <sub>L</sub> = 50pF | 6                   | -    | -   | 43   | -             | 54    | -              | 64    | ns    |
| $\overline{R}$ to Q                                                | t <sub>PHL</sub>                    | C <sub>L</sub> = 50pF | 2                   | -    | -   | 250  | -             | 315   | -              | 375   | ns    |
|                                                                    |                                     |                       | 4.5                 | -    | -   | 50   | -             | 63    | -              | 75    | ns    |
|                                                                    |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 21  | -    | -             | -     | -              | -     | ns    |
|                                                                    |                                     | C <sub>L</sub> = 50pF | 6                   | -    | -   | 43   | -             | 54    | -              | 64    | ns    |
| $\overline{R}$ to $\overline{Q}$                                   | t <sub>PLH</sub>                    | C <sub>L</sub> = 50pF | 2                   | -    | -   | 250  | -             | 315   | -              | 375   | ns    |
|                                                                    |                                     |                       | 4.5                 | -    | -   | 50   | -             | 63    | -              | 75    | ns    |
|                                                                    |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 21  | -    | -             | -     | -              | -     | ns    |
|                                                                    |                                     | C <sub>L</sub> = 50pF | 6                   | -    | -   | 43   | -             | 54    | -              | 64    | ns    |
| Output Transition Time                                             | t <sub>TLH</sub> , t <sub>THL</sub> | C <sub>L</sub> = 50pF | 2                   | -    | -   | 75   | -             | 95    | -              | 110   | ns    |
|                                                                    |                                     |                       | 4.5                 | -    | -   | 15   | -             | 19    | -              | 22    | ns    |
|                                                                    |                                     |                       | 6                   | -    | -   | 13   | -             | 16    | -              | 19    | ns    |
| Output Pulse Width<br>R <sub>X</sub> = 10k, C <sub>X</sub> = 0.1μF | τ                                   | C <sub>L</sub> = 50pF | 3                   | 0.64 | -   | 0.78 | 0.612         | 0.812 | 0.605          | 0.819 | ms    |
|                                                                    |                                     |                       | 5                   | 0.63 | -   | 0.77 | 0.602         | 0.798 | 0.595          | 0.805 | ms    |
| Output Pulse Width Match,<br>Same Package                          | -                                   | -                     |                     | -    | ±1  | -    | -             | -     | -              | -     | %     |
| Power Dissipation Capacitance<br>(Notes 8, 9)                      | C <sub>PD</sub>                     | C <sub>L</sub> = 15pF | 5                   | -    | 136 | -    | -             | -     | -              | -     | pF    |
| Input Capacitance                                                  | C <sub>I</sub>                      | C <sub>L</sub> = 50pF | -                   | 10   | -   | 10   | -             | 10    | -              | 10    | pF    |
| HCT TYPES                                                          |                                     |                       |                     |      |     |      |               |       |                |       |       |
| Propagation Delay<br>A, $\overline{B}$ to Q                        | t <sub>PLH</sub>                    | C <sub>L</sub> = 50pF | 4.5                 | -    | -   | 55   | -             | 69    | -              | 83    | ns    |
|                                                                    |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 23  | -    | -             | -     | -              | -     | ns    |
| A, $\overline{B}$ to $\overline{Q}$                                | t <sub>PHL</sub>                    | C <sub>L</sub> = 50pF | 4.5                 | -    | -   | 55   | -             | 69    | -              | 83    | ns    |
|                                                                    |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 23  | -    | -             | -     | -              | -     | ns    |

# CD54HC4538, CD74HC4538, CD54HCT4538, CD74HCT4538

**Switching Specifications**  $C_L = 50\text{pF}$ , Input  $t_r, t_f = 6\text{ns}$ ,  $R_X = 10\text{K}\Omega$ ,  $C_X = 0$  (Continued)

| PARAMETER                                                         | SYMBOL             | TEST CONDITIONS     | $V_{CC}$ (V) | 25°C |         |      | -40°C TO 85°C |       | -55°C TO 125°C |       | UNITS |
|-------------------------------------------------------------------|--------------------|---------------------|--------------|------|---------|------|---------------|-------|----------------|-------|-------|
|                                                                   |                    |                     |              | MIN  | TYP     | MAX  | MIN           | MAX   | MIN            | MAX   |       |
| $\bar{R}$ to Q                                                    | $t_{PHL}$          | $C_L = 50\text{pF}$ | 4.5          | -    | -       | 40   | -             | 50    | -              | 60    | ns    |
|                                                                   |                    | $C_L = 15\text{pF}$ | 5            | -    | 17      | -    | -             | -     | -              | -     | ns    |
| $\bar{R}$ to $\bar{Q}$                                            | $t_{PLH}$          | $C_L = 50\text{pF}$ | 4.5          | -    | -       | 50   | -             | 63    | -              | 75    | ns    |
|                                                                   |                    | $C_L = 15\text{pF}$ | 5            | -    | 21      | -    | -             | -     | -              | -     | ns    |
| Output Transition Time                                            | $t_{TLH}, t_{THL}$ | $C_L = 50\text{pF}$ | 4.5          | -    | -       | 15   | -             | 19    | -              | 22    | ns    |
| Output Pulse Width<br>$R_X = 10\text{k}$ , $C_X = 0.1\mu\text{F}$ | $\tau$             | $C_L = 50\text{pF}$ | 5            | 0.63 | -       | 0.77 | 0.602         | 0.798 | 0.595          | 0.805 | ms    |
| Output Pulse Width Match,<br>Same Package                         | -                  | -                   | -            | -    | $\pm 1$ | -    | -             | -     | -              | -     | %     |
| Power Dissipation Capacitance<br>(Notes 8, 9)                     | $C_{PD}$           | $C_L = 15\text{pF}$ | 5            | -    | 134     | -    | -             | -     | -              | -     | pF    |
| Input Capacitance                                                 | $C_I$              | $C_L = 50\text{pF}$ | -            | 10   | -       | 10   | -             | 10    | -              | 10    | pF    |

NOTES:

- $C_{PD}$  is used to determine the dynamic power consumption, per one shot.
- $P_D = (C_{PD} + C_X) V_{CC}^2 f_i \sum (C_L V_{CC}^2 f_O)$  where  $f_i$  = input frequency,  $f_O$  = output frequency,  $C_L$  = output load capacitance,  $C_X$  = external capacitance  $V_{CC}$  = supply voltage assuming  $f_i \ll \frac{1}{\tau}$

## Test Circuits and Waveforms

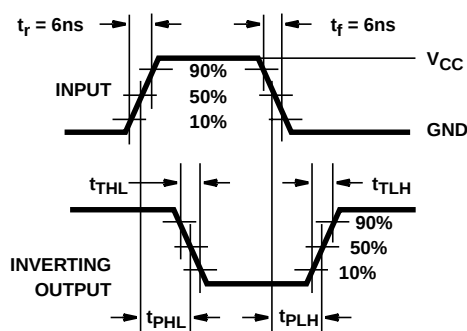


FIGURE 6. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

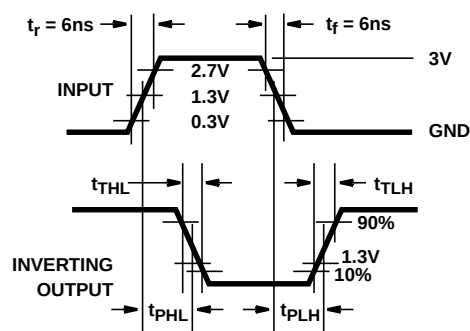


FIGURE 7. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

# Typical Performance Curves

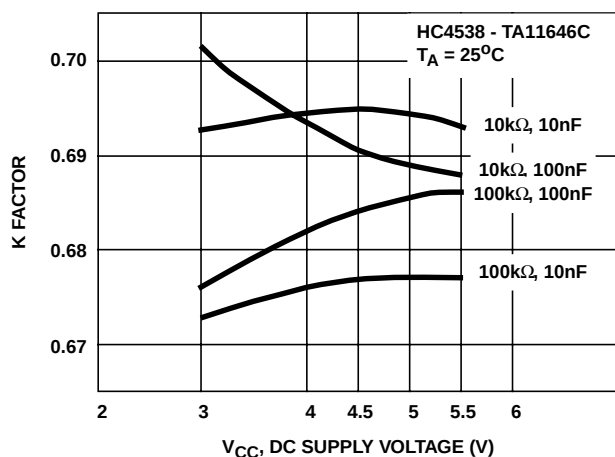


FIGURE 8. K FACTOR vs DC SUPPLY VOLTAGE (V<sub>CC</sub>) - V

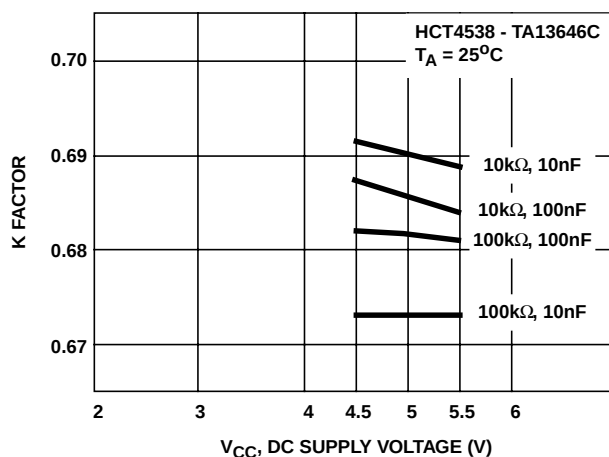


FIGURE 9. K FACTOR vs DC SUPPLY VOLTAGE (V<sub>CC</sub>) - V

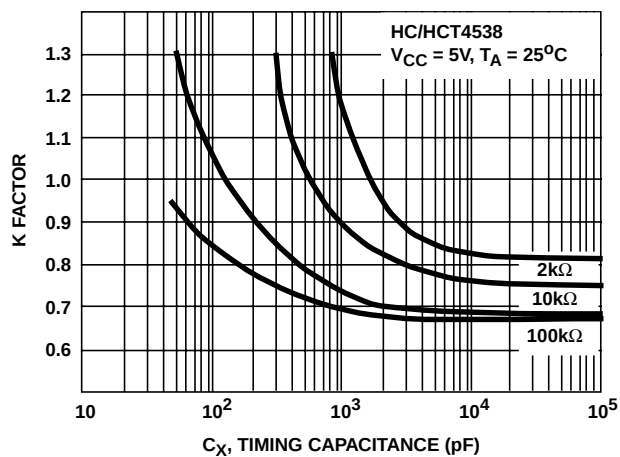


FIGURE 10. K FACTOR vs C<sub>X</sub>

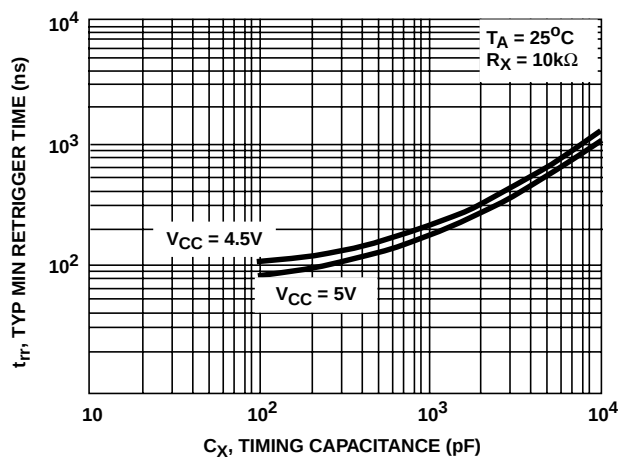


FIGURE 11. MINIMUM RETRIGGER TIME vs TIMING CAPACITANCE

## Power-Down Mode

During a rapid power-down condition, as would occur with a power-supply short circuit with a poorly filtered power supply, the energy stored in  $C_X$  could discharge into Pin 2 or 14. To avoid possible device damage in this mode, when  $C_X$  is  $\geq 0.5\mu\text{F}$ , a protection diode with a 1 ampere or higher rating (1N5395 or equivalent) and a separate ground return for  $C_X$  should be provided as shown in Figure 12.

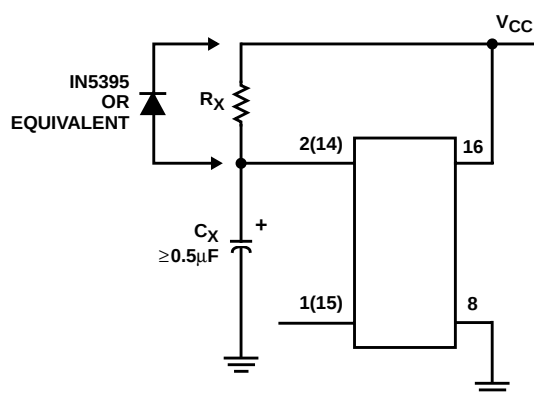


FIGURE 12. RAPID POWER-DOWN PROTECTION CIRCUIT

An alternate protection method is shown in Figure 13, where a  $51\Omega$  current-limiting resistor is inserted in series with  $C_X$ . Note that a small pulse width decrease will occur however, and  $R_X$  must be appropriately increased to obtain the originally desired pulse width.

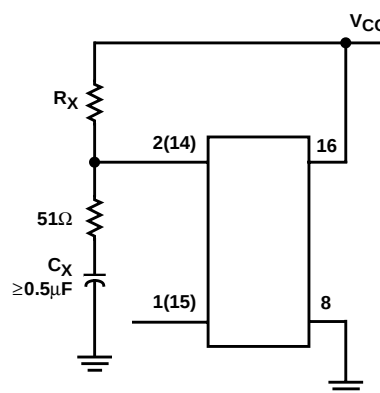


FIGURE 13. ALTERNATE RAPID POWER-DOWN PROTECTION CIRCUIT

## PACKAGING INFORMATION

| Orderable part number          | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)             |
|--------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------------------|
| <a href="#">5962-8688601EA</a> | Active        | Production           | CDIP (J)   16   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8688601EA<br>CD54HC4538F3A |
| <a href="#">CD54HC4538F</a>    | Active        | Production           | CDIP (J)   16   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | CD54HC4538F                     |
| CD54HC4538F.A                  | Active        | Production           | CDIP (J)   16   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | CD54HC4538F                     |
| <a href="#">CD54HC4538F3A</a>  | Active        | Production           | CDIP (J)   16   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8688601EA<br>CD54HC4538F3A |
| CD54HC4538F3A.A                | Active        | Production           | CDIP (J)   16   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-8688601EA<br>CD54HC4538F3A |
| <a href="#">CD54HCT4538F3A</a> | Active        | Production           | CDIP (J)   16   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | CD54HCT4538F3A                  |
| CD54HCT4538F3A.A               | Active        | Production           | CDIP (J)   16   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | CD54HCT4538F3A                  |
| <a href="#">CD74HC4538E</a>    | Active        | Production           | PDIP (N)   16   | 25   TUBE             | Yes         | NIPDAU                               | N/A for Pkg Type                  | -55 to 125   | CD74HC4538E                     |
| CD74HC4538E.A                  | Active        | Production           | PDIP (N)   16   | 25   TUBE             | Yes         | NIPDAU                               | N/A for Pkg Type                  | -55 to 125   | CD74HC4538E                     |
| CD74HC4538EE4                  | Active        | Production           | PDIP (N)   16   | 25   TUBE             | Yes         | NIPDAU                               | N/A for Pkg Type                  | -55 to 125   | CD74HC4538E                     |
| <a href="#">CD74HC4538M</a>    | Obsolete      | Production           | SOIC (D)   16   | -                     | -           | Call TI                              | Call TI                           | -55 to 125   | HC4538M                         |
| <a href="#">CD74HC4538M96</a>  | Active        | Production           | SOIC (D)   16   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HC4538M                         |
| CD74HC4538M96.A                | Active        | Production           | SOIC (D)   16   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HC4538M                         |
| CD74HC4538M96E4                | Active        | Production           | SOIC (D)   16   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HC4538M                         |
| CD74HC4538M96G4                | Active        | Production           | SOIC (D)   16   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HC4538M                         |
| <a href="#">CD74HC4538MT</a>   | Obsolete      | Production           | SOIC (D)   16   | -                     | -           | Call TI                              | Call TI                           | -55 to 125   | HC4538M                         |
| <a href="#">CD74HC4538NSR</a>  | Active        | Production           | SOP (NS)   16   | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HC4538M                         |
| CD74HC4538NSR.A                | Active        | Production           | SOP (NS)   16   | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HC4538M                         |
| <a href="#">CD74HC4538PW</a>   | Obsolete      | Production           | TSSOP (PW)   16 | -                     | -           | Call TI                              | Call TI                           | -55 to 125   | HJ4538                          |
| <a href="#">CD74HC4538PWR</a>  | Active        | Production           | TSSOP (PW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HJ4538                          |
| CD74HC4538PWR.A                | Active        | Production           | TSSOP (PW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HJ4538                          |
| CD74HC4538PWRG4                | Active        | Production           | TSSOP (PW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HJ4538                          |
| <a href="#">CD74HC4538PWT</a>  | Obsolete      | Production           | TSSOP (PW)   16 | -                     | -           | Call TI                              | Call TI                           | -55 to 125   | HJ4538                          |
| <a href="#">CD74HCT4538E</a>   | Active        | Production           | PDIP (N)   16   | 25   TUBE             | Yes         | NIPDAU                               | N/A for Pkg Type                  | -55 to 125   | CD74HCT4538E                    |
| CD74HCT4538E.A                 | Active        | Production           | PDIP (N)   16   | 25   TUBE             | Yes         | NIPDAU                               | N/A for Pkg Type                  | -55 to 125   | CD74HCT4538E                    |
| <a href="#">CD74HCT4538M</a>   | Obsolete      | Production           | SOIC (D)   16   | -                     | -           | Call TI                              | Call TI                           | -55 to 125   | HCT4538M                        |
| <a href="#">CD74HCT4538M96</a> | Active        | Production           | SOIC (D)   16   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HCT4538M                        |

| Orderable part number         | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| CD74HCT4538M96.A              | Active        | Production           | SOIC (D)   16  | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | HCT4538M            |
| <a href="#">CD74HCT4538MT</a> | Obsolete      | Production           | SOIC (D)   16  | -                     | -           | Call TI                              | Call TI                           | -55 to 125   | HCT4538M            |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## OTHER QUALIFIED VERSIONS OF CD54HC4538, CD54HCT4538, CD74HC4538, CD74HCT4538 :

● Catalog : [CD74HC4538](#), [CD74HCT4538](#)

● Automotive : [CD74HC4538-Q1](#), [CD74HCT4538-Q1](#)

- Military : [CD54HC4538](#), [CD54HCT4538](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Military - QML certified for Military and Defense Applications

## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CD74HC4538M96  | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |
| CD74HC4538NSR  | SOP          | NS              | 16   | 2000 | 330.0              | 16.4               | 8.1     | 10.4    | 2.5     | 12.0    | 16.0   | Q1            |
| CD74HC4538PWR  | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| CD74HCT4538M96 | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CD74HC4538M96  | SOIC         | D               | 16   | 2500 | 353.0       | 353.0      | 32.0        |
| CD74HC4538NSR  | SOP          | NS              | 16   | 2000 | 353.0       | 353.0      | 32.0        |
| CD74HC4538PWR  | TSSOP        | PW              | 16   | 2000 | 353.0       | 353.0      | 32.0        |
| CD74HCT4538M96 | SOIC         | D               | 16   | 2500 | 353.0       | 353.0      | 32.0        |

**TUBE**


\*All dimensions are nominal

| Device         | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|----------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| CD74HC4538E    | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HC4538E    | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HC4538E.A  | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HC4538E.A  | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HC4538EE4  | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HC4538EE4  | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HCT4538E   | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HCT4538E   | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HCT4538E.A | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| CD74HCT4538E.A | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |



**NS0016A**

**SOP - 2.00 mm max height**

SOP



NOTES:

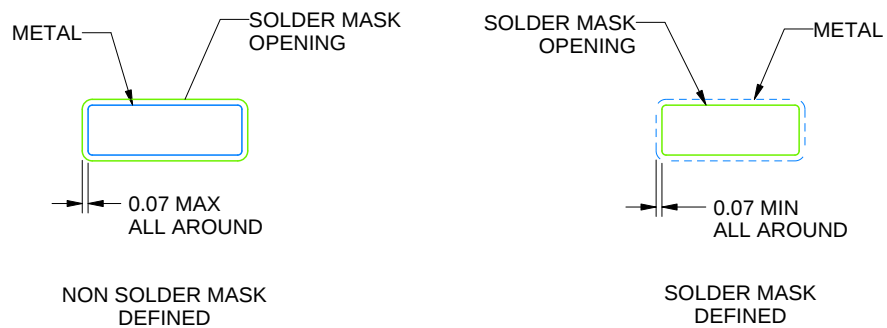
1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.

# EXAMPLE BOARD LAYOUT

NS0016A

SOP - 2.00 mm max height

SOP



SOLDER MASK DETAILS

4220735/A 12/2021

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE  
 BASED ON 0.125 mm THICK STENCIL  
 SCALE:7X

4220735/A 12/2021

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AC.

J (R-GDIP-T\*\*)

14 LEADS SHOWN

# CERAMIC DUAL IN-LINE PACKAGE



| PINS **<br>DIM | 14                     | 16                     | 18                     | 20                     |
|----------------|------------------------|------------------------|------------------------|------------------------|
| A              | 0.300<br>(7,62)<br>BSC | 0.300<br>(7,62)<br>BSC | 0.300<br>(7,62)<br>BSC | 0.300<br>(7,62)<br>BSC |
| B MAX          | 0.785<br>(19,94)       | .840<br>(21,34)        | 0.960<br>(24,38)       | 1.060<br>(26,92)       |
| B MIN          | —                      | —                      | —                      | —                      |
| C MAX          | 0.300<br>(7,62)        | 0.300<br>(7,62)        | 0.310<br>(7,87)        | 0.300<br>(7,62)        |
| C MIN          | 0.245<br>(6,22)        | 0.245<br>(6,22)        | 0.220<br>(5,59)        | 0.245<br>(6,22)        |



4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package is hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.



**PW0016A**

**TSSOP - 1.2 mm max height**

SMALL OUTLINE PACKAGE



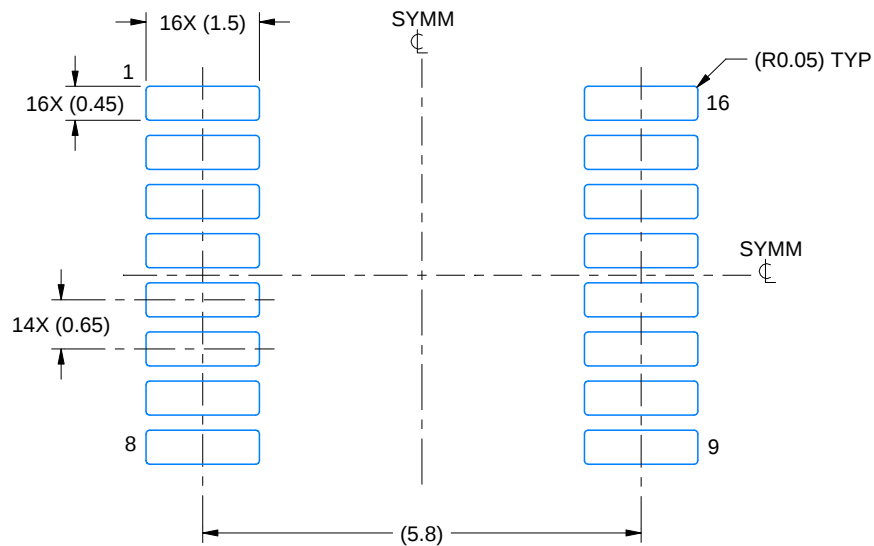
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

# EXAMPLE BOARD LAYOUT

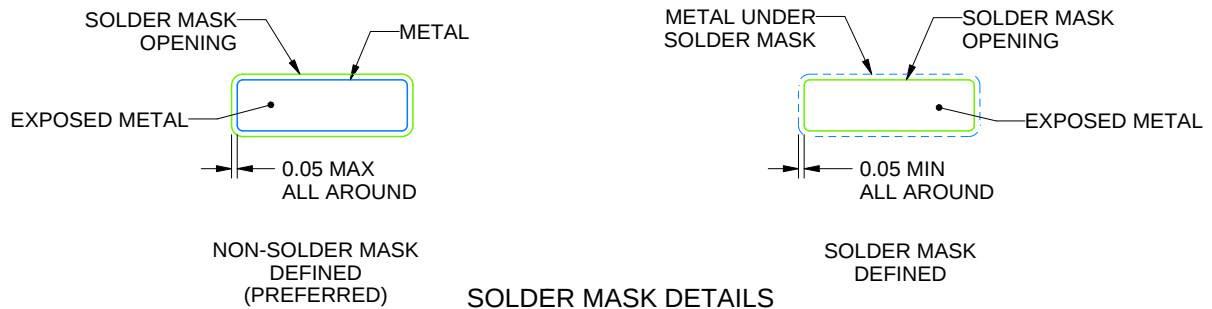
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



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NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE



| PINS **<br>DIM      | 14               | 16               | 18               | 20               |
|---------------------|------------------|------------------|------------------|------------------|
| A MAX               | 0.775<br>(19,69) | 0.775<br>(19,69) | 0.920<br>(23,37) | 1.060<br>(26,92) |
| A MIN               | 0.745<br>(18,92) | 0.745<br>(18,92) | 0.850<br>(21,59) | 0.940<br>(23,88) |
| MS-001<br>VARIATION | AA               | BB               | AC               | AD               |



4040049/E 12/2002

NOTES:

- A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.
-  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).  
 The 20 pin end lead shoulder width is a vendor option, either half or full width.

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