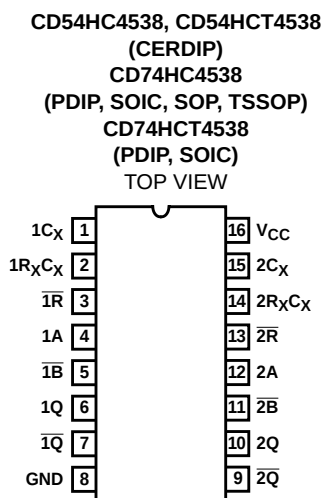


## High-Speed CMOS Logic Dual Retriggerable Precision Monostable Multivibrator

### 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  $C_X$ .

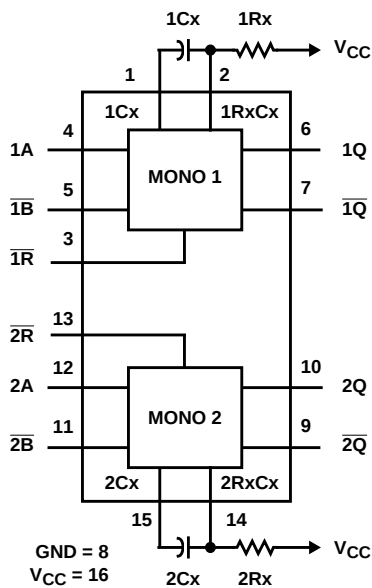
Leading-edge triggering (A) and trailing edge triggering ( $\bar{B}$ ) inputs are provided for triggering from either edge of the input pulse. An unused "A" input should be tied to GND and an unused  $\bar{B}$  should be tied to  $V_{CC}$ . On power up the IC is reset. Unused resets and sections must 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.

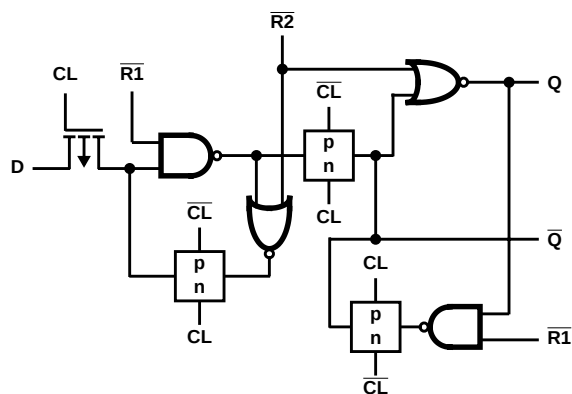


FIGURE 1. FF DETAIL

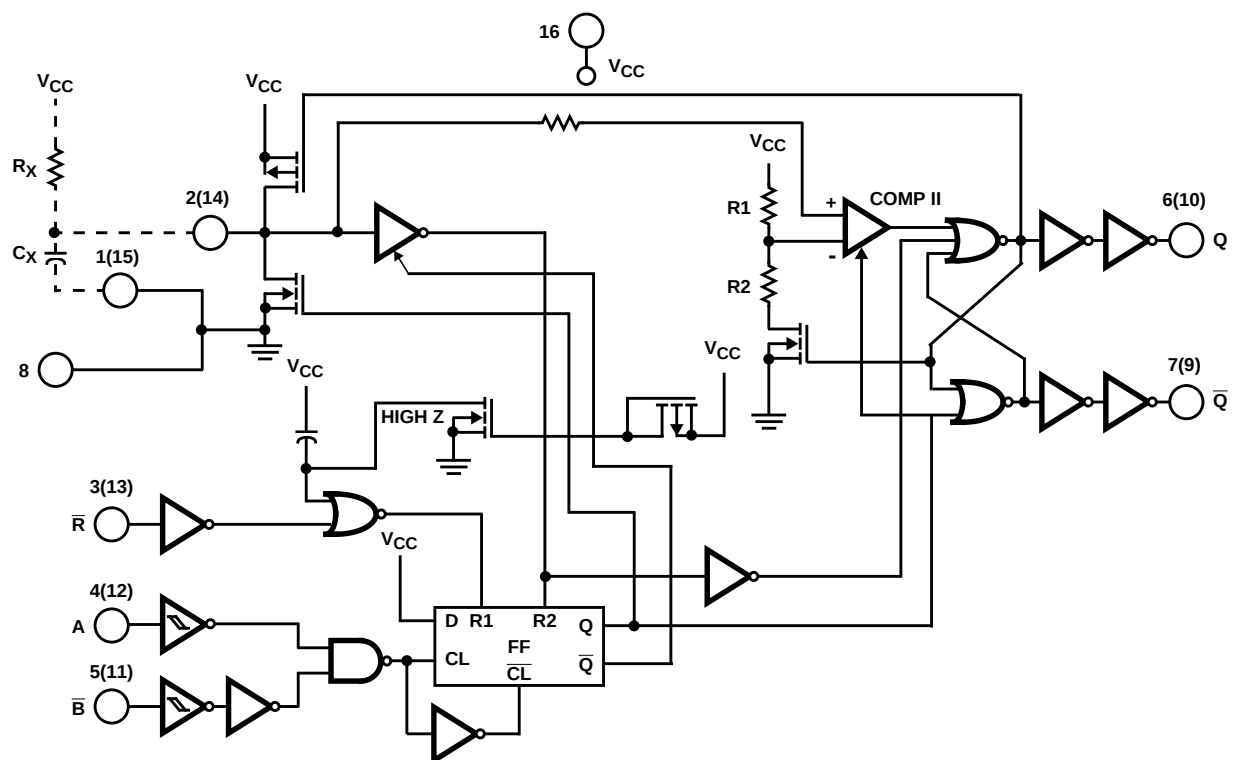


FIGURE 2. LOGIC DIAGRAM (1 MONO)

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

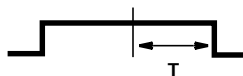


FIGURE 4. RETRIGGERABLE MODE  
PULSE WIDTH (A MODE)

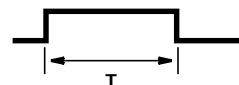


FIGURE 5. NON-RETRIGGERABLE MODE  
PULSE WIDTH  
(A MODE)

# 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     |

**CD54HC4538, CD74HC4538, CD54HCT4538, CD74HCT4538**

**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

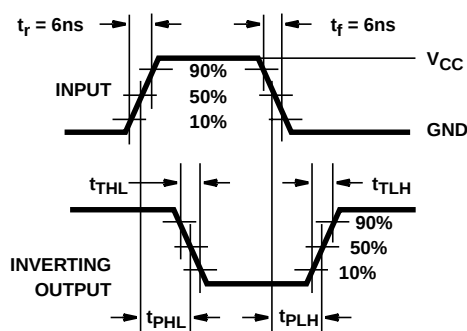


FIGURE 6. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

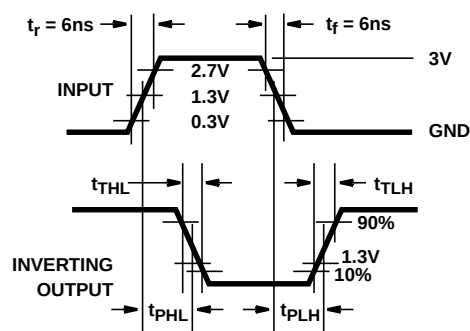


FIGURE 7. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

## Typical Performance Curves

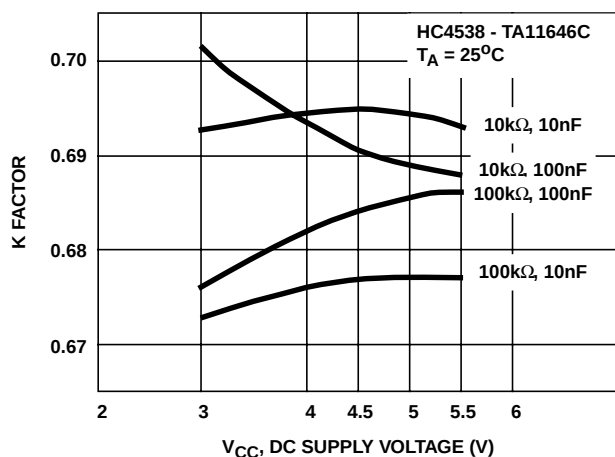


FIGURE 8. K FACTOR vs DC SUPPLY VOLTAGE ( $V_{CC}$ ) - V

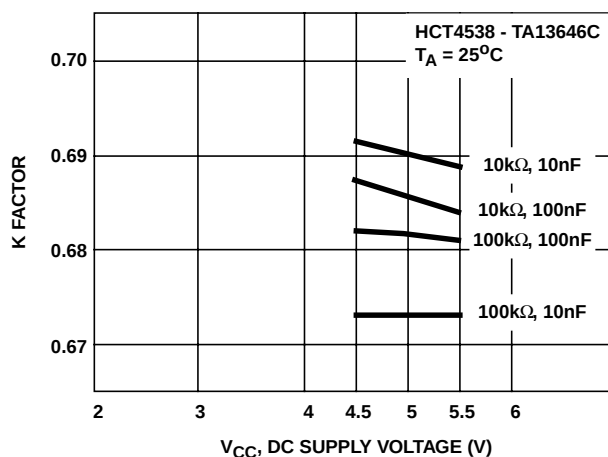


FIGURE 9. K FACTOR vs DC SUPPLY VOLTAGE ( $V_{CC}$ ) - V

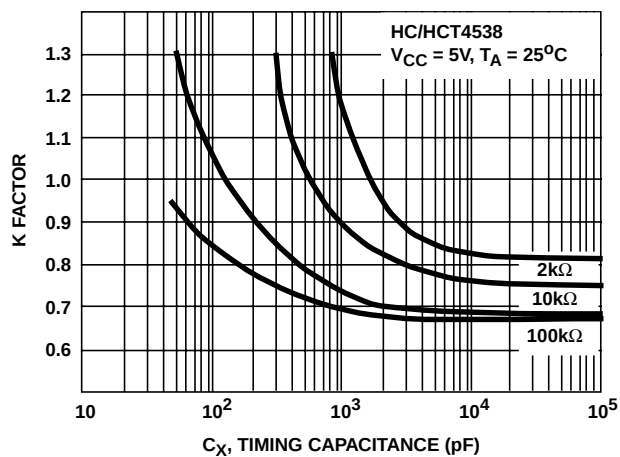


FIGURE 10. K FACTOR vs  $C_X$

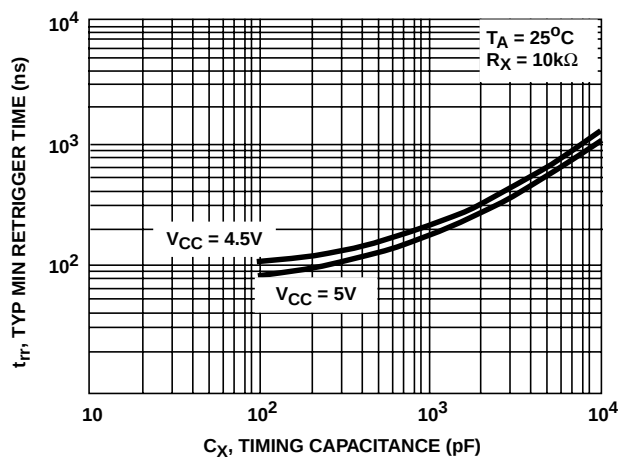


FIGURE 11. MINIMUM RETRIGGER TIME vs TIMING CAPACITANCE

## 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.

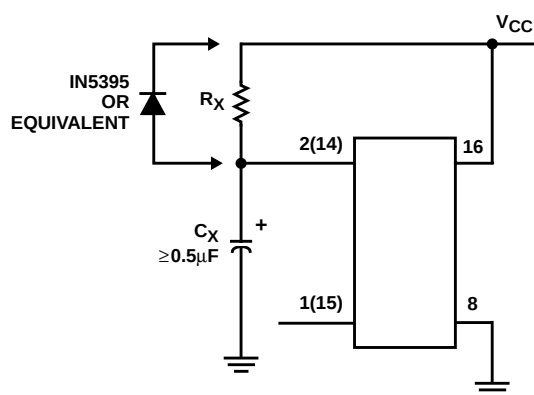


FIGURE 12. RAPID POWER-DOWN PROTECTION CIRCUIT

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.

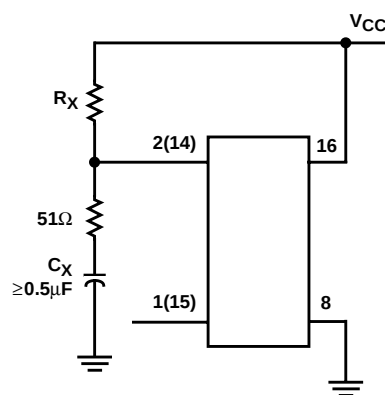


FIGURE 13. ALTERNATE RAPID POWER-DOWN PROTECTION CIRCUIT

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 5962-8688601EA   | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42              | N / A for Pkg Type           |
| CD54HC4538F      | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42              | N / A for Pkg Type           |
| CD54HC4538F3A    | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42              | N / A for Pkg Type           |
| CD54HCT4538F3A   | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42              | N / A for Pkg Type           |
| CD74HC4538E      | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HC4538EE4    | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HC4538M      | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538M96    | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538M96E4  | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538M96G4  | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538ME4    | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538MG4    | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538MT     | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538MTE4   | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538MTG4   | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538NSR    | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538NSRE4  | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538NSRG4  | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PW     | ACTIVE                | TSSOP        | PW              | 16   | 90          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PWE4   | ACTIVE                | TSSOP        | PW              | 16   | 90          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PWG4   | ACTIVE                | TSSOP        | PW              | 16   | 90          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PWR    | ACTIVE                | TSSOP        | PW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PWRE4  | ACTIVE                | TSSOP        | PW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PWRG4  | ACTIVE                | TSSOP        | PW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PWT    | ACTIVE                | TSSOP        | PW              | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PWTE4  | ACTIVE                | TSSOP        | PW              | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HC4538PWTG4  | ACTIVE                | TSSOP        | PW              | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| no Sb/Br)        |                       |              |                 |      |             |                         |                  |                              |
| CD74HCT4538E     | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HCT4538EE4   | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD74HCT4538M     | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT4538M96   | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT4538M96E4 | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT4538M96G4 | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT4538ME4   | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT4538MG4   | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT4538MT    | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT4538MTE4  | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD74HCT4538MTG4  | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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

- Automotive: [CD74HC4538-Q1](#)

**NOTE: Qualified Version Definitions:**

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

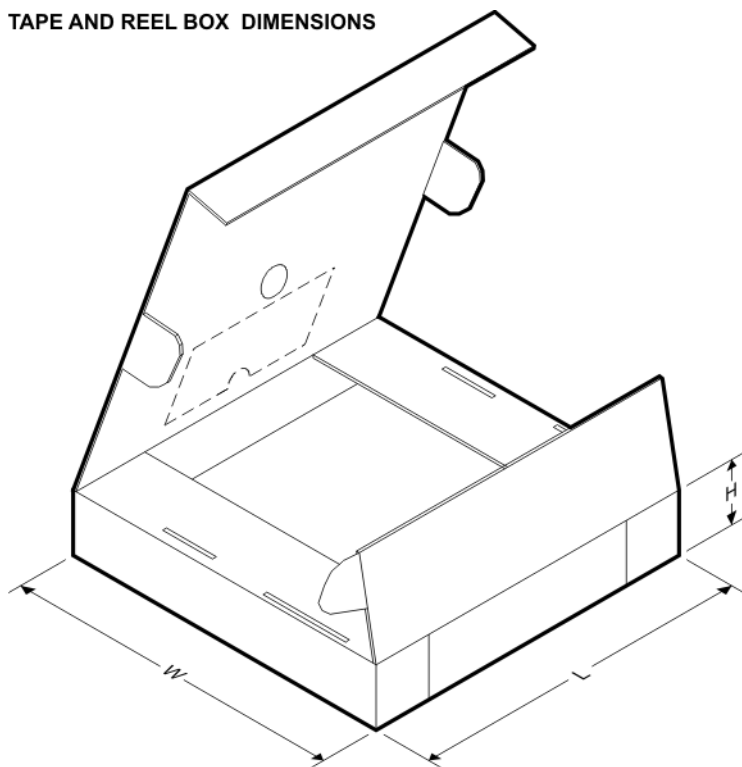
**TAPE AND REEL INFORMATION**



\*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  | SO           | NS              | 16   | 2000 | 330.0              | 16.4               | 8.2     | 10.5    | 2.5     | 12.0    | 16.0   | Q1            |
| CD74HC4538PWR  | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 7.0     | 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

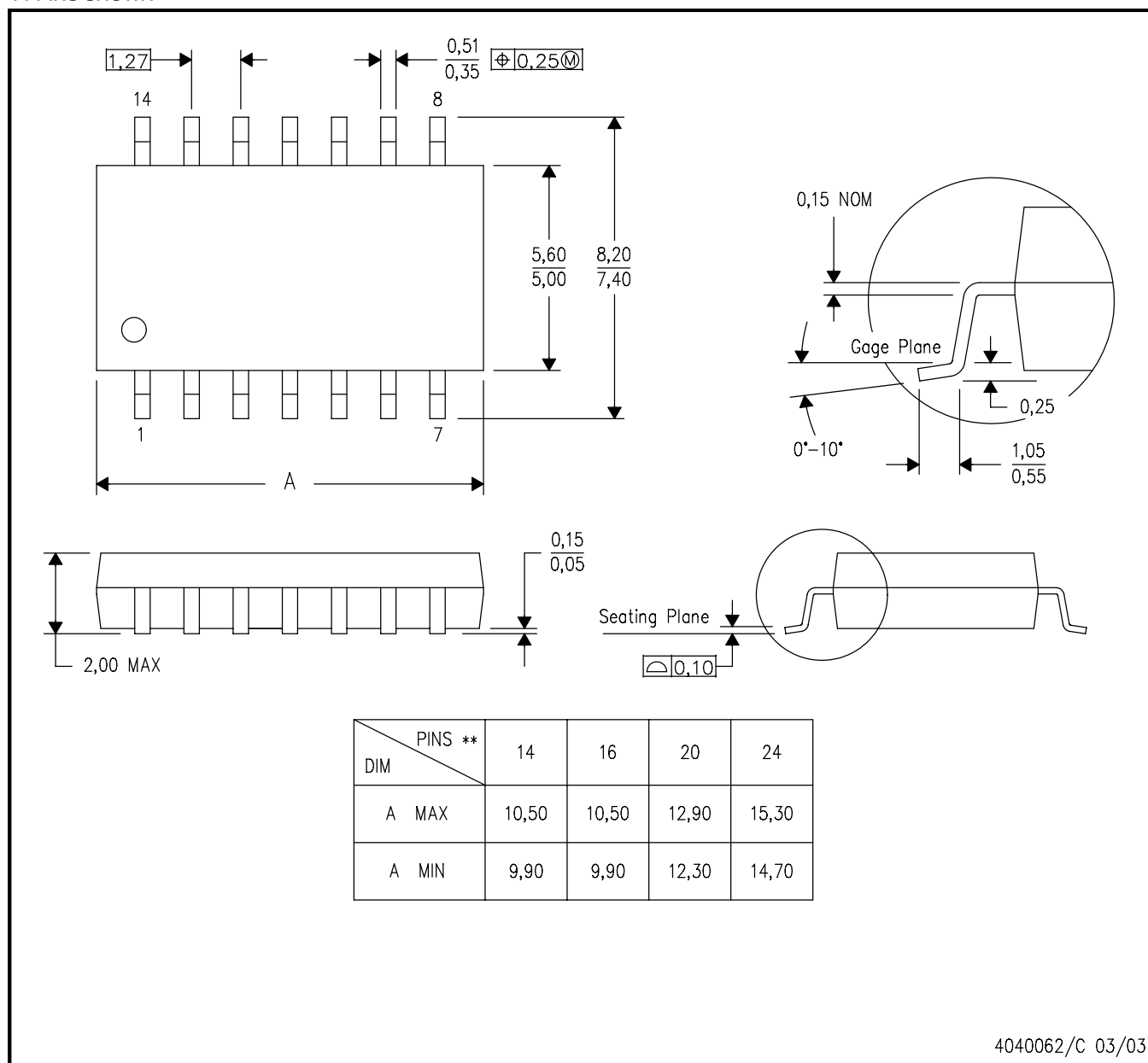
| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CD74HC4538M96  | SOIC         | D               | 16   | 2500 | 333.2       | 345.9      | 28.6        |
| CD74HC4538NSR  | SO           | NS              | 16   | 2000 | 346.0       | 346.0      | 33.0        |
| CD74HC4538PWR  | TSSOP        | PW              | 16   | 2000 | 346.0       | 346.0      | 29.0        |
| CD74HCT4538M96 | SOIC         | D               | 16   | 2500 | 333.2       | 345.9      | 28.6        |

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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.

## PW (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

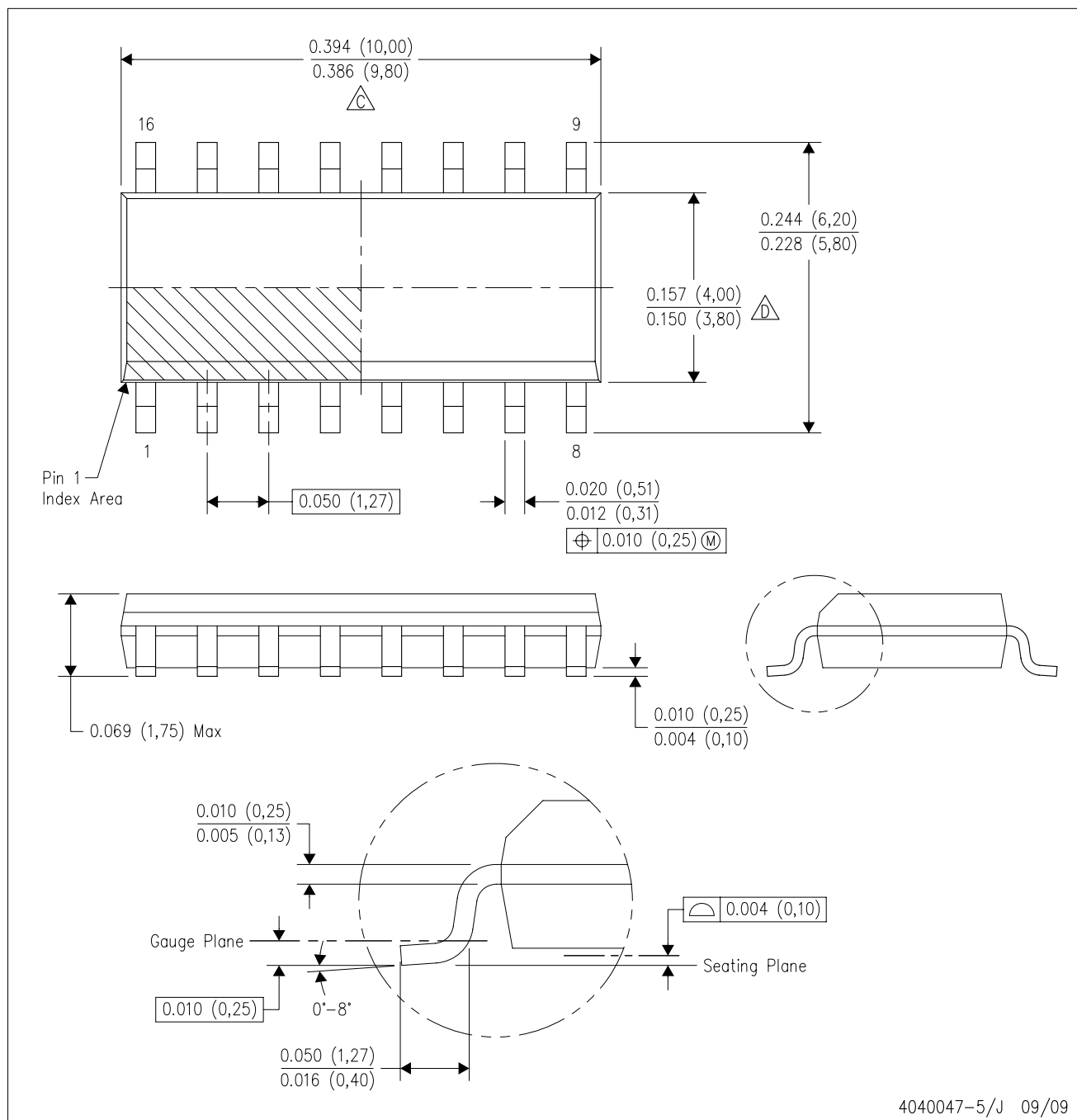
14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-5/J 09/09

## NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
- D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
- E. Reference JEDEC MS-012 variation AC.

## D(R-PDSO-G16)



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Refer to IPC7351 for alternate board design.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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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