

# CD54HC4538, CD74HC4538, 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
- Retrig 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  $V_{OL}$ ,  $V_{OH}$

### Description

The Harris CD54HC4538, CD74HC4538 and CD74HCT4538 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

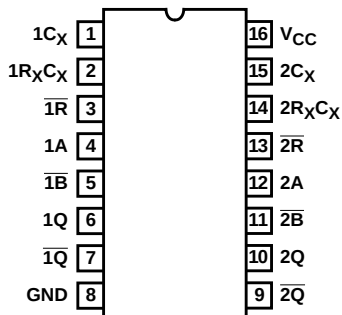
| PART NUMBER  | TEMP. RANGE (°C) | PACKAGE      | PKG. NO. |
|--------------|------------------|--------------|----------|
| CD54HC4538F  | -55 to 125       | 16 Ld Cerdip | F16.3    |
| CD74HC4538E  | -55 to 125       | 16 Ld PDIP   | E16.3    |
| CD74HCT4538E | -55 to 125       | 16 Ld PDIP   | E16.3    |
| CD74HC4538M  | -55 to 125       | 16 Ld SOIC   | M16.15   |
| CD74HCT4538M | -55 to 125       | 16 Ld SOIC   | M16.15   |

#### NOTES:

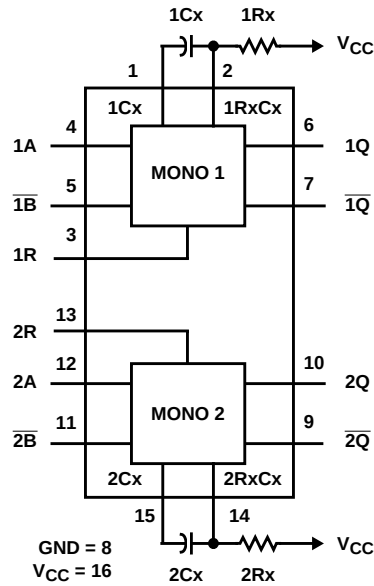
1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. Wafer and die for this part number is available which meets all electrical specifications. Please contact your local sales office or Harris customer service for ordering information.

### Pinout

CD54HC4538, CD74HC4538, CD74HCT4538  
(PDIP, SOIC, Cerdip)  
TOP VIEW



## Functional Diagram



TRUTH TABLE

| INPUTS    |            |              | OUTPUTS                       |                              |
|-----------|------------|--------------|-------------------------------|------------------------------|
| $\bar{R}$ | A          | $\bar{B}$    | Q                             | $\bar{Q}$                    |
| L         | X          | X            | L                             | H                            |
| X         | H          | X            | L                             | H                            |
| X         | X          | L            | L                             | H                            |
| H         | L          | $\downarrow$ | $\text{One High Level Pulse}$ | $\text{One Low Level Pulse}$ |
| H         | $\uparrow$ | H            | $\text{One High Level Pulse}$ | $\text{One Low Level Pulse}$ |

NOTE: H = High Level, L = Low Level,  $\uparrow$  = Transition from Low to High,  $\downarrow$  = Transition from High to Low,  $\text{One High Level Pulse}$ ,  $\text{One Low Level Pulse}$ , X = Irrelevant.

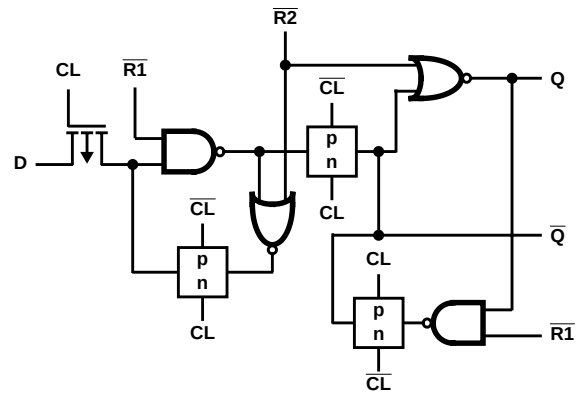


FIGURE 1. FF DETAIL

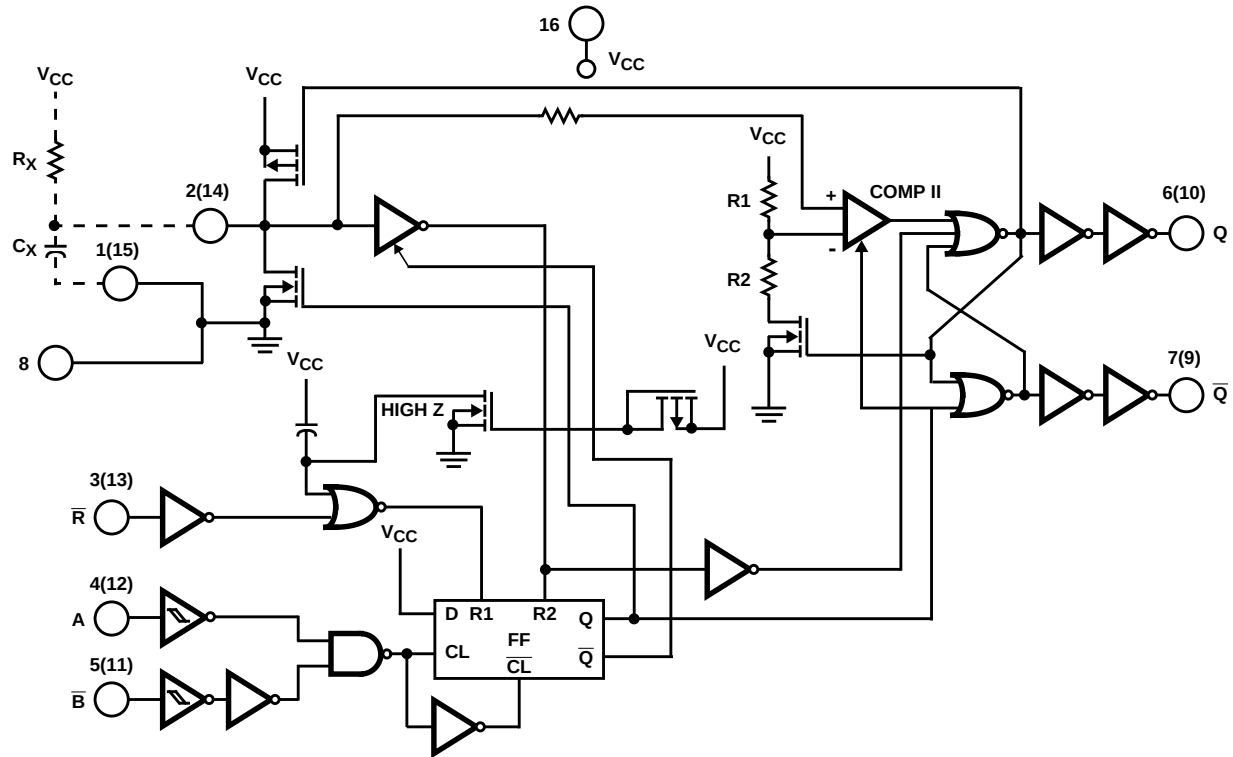


FIGURE 2. LOGIC DIAGRAM (1 MONO)

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:

- 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.
- 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

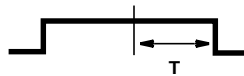


FIGURE 4. RETRIGGERABLE MODE  
PULSE WIDTH (A MODE)

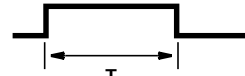


FIGURE 5. NON-RETRIGGERABLE MODE  
PULSE WIDTH  
(A MODE)

# CD54HC4538, CD74HC4538, 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, $I_{CC}$                | $\pm 50mA$  |

## Thermal Information

| Thermal Resistance (Typical, Note 7)               | $\theta_{JA}$ ( $^{\circ}C/W$ )    | $\theta_{JC}$ ( $^{\circ}C/W$ ) |
|----------------------------------------------------|------------------------------------|---------------------------------|
| PDIP Package . . . . .                             | 90                                 | N/A                             |
| SOIC Package . . . . .                             | 160                                | N/A                             |
| CERDIP Package . . . . .                           | 130                                | 55                              |
| Maximum Junction Temperature . . . . .             | 150 $^{\circ}C$                    |                                 |
| Maximum Storage Temperature Range . . . . .        | -65 $^{\circ}C$ to 150 $^{\circ}C$ |                                 |
| Maximum Lead Temperature (Soldering 10s) . . . . . | 300 $^{\circ}C$                    |                                 |
| (SOIC - Lead Tips Only)                            |                                    |                                 |

## Operating Conditions

|                                           |                                    |
|-------------------------------------------|------------------------------------|
| Temperature Range, $T_A$                  | -55 $^{\circ}C$ to 125 $^{\circ}C$ |
| Supply Voltage Range, $V_{CC}$ (Note 5)   |                                    |
| 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 6)  | .5k $\Omega$ (Min)                 |
| External Timing Capacitor, $C_X$ (Note 6) | 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  $R_X > 1M\Omega$ .
- $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

## 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     |
| -                                       |                 |                                    | -                   | -                   | -    | -   | -    | -             | -    | -              | V    |       |
| -4                                      |                 |                                    | 4.5                 | 3.98                | -    | -   | 3.84 | -             | 3.7  | -              | V    |       |
| -5.2                                    |                 |                                    | 6                   | 5.48                | -    | -   | 5.34 | -             | 5.2  | -              | V    |       |
| High Level Output Voltage<br>TTL Loads  |                 |                                    |                     |                     |      |     |      |               |      |                |      |       |

**CD54HC4538, CD74HC4538, 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 9)      |                              |                                    | -                   | 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 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 9)      |                              |                                    | -                   | 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 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 Input Pin: 1 Unit Load       | ΔI <sub>CC</sub><br>(Note 8) | V <sub>CC</sub> -2.1               | -                   | 4.5 to 5.5          | -    | 100 | 360   | -             | 450  | -              | 490  | µA    |

**NOTES:**

- For dual-supply systems theoretical worst case (V<sub>I</sub> = 2.4V, V<sub>CC</sub> = 5.5V) specification is 1.8mA.
- 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.

**CD54HC4538, CD74HC4538, 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)           | $t_{rr}$         | 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)           | $t_{rr}$         | 5                   | -        | 175 | -   | -             | -   | -   | -              | -   | -   | ns    |

**CD54HC4538, CD74HC4538, 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<br>CONDITIONS    | V <sub>CC</sub> (V) | 25°C |     |      | -40°C TO<br>85°C |       | -55°C TO<br>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                                      | 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    |
| $\overline{R}$ to Q                                                | t <sub>PHL</sub>                    | C <sub>L</sub> = 50pF | 4.5                 | -    | -   | 40   | -                | 50    | -                 | 60    | ns    |
|                                                                    |                                     | C <sub>L</sub> = 15pF | 5                   | -    | 17  | -    | -                | -     | -                 | -     | ns    |

# **CD54HC4538, CD74HC4538, CD74HCT4538**

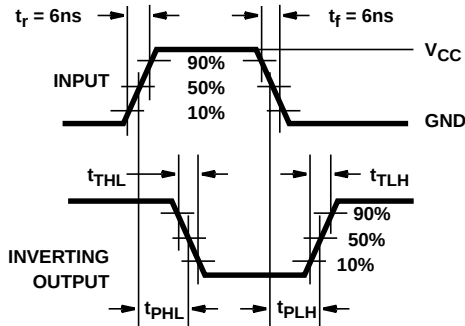
## **Switching Specifications** $C_L = 50\text{pF}$ , Input $t_r, t_f = 6\text{ns}$ , $R_X = 10\text{K}\Omega$ , $C_X = 0$ (Continued)

| 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 $\bar{Q}$                                            | $t_{PLH}$          | $C_L = 50\text{pF}$ | 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, Same Package                            | -                  | -                   | -            | -    | $\pm 1$ | -    | -             | -     | -              | -     | %     |
| Power Dissipation Capacitance                                     | $C_{PD}$           | $C_L = 15\text{pF}$ | 5            | -    | 134     | -    | -             | -     | -              | -     | pF    |
| Input Capacitance                                                 | $C_I$              | $C_L = 50\text{pF}$ | -            | 10   | -       | 10   | -             | 10    | -              | 10    | pF    |

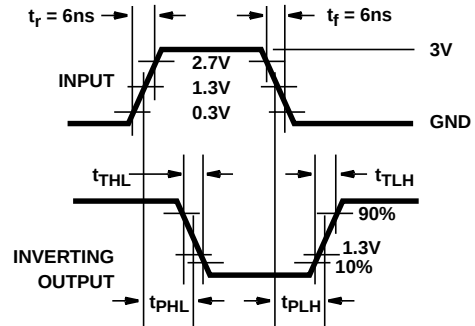
### NOTES:

10.  $C_{PD}$  is used to determine the dynamic power consumption, per one shot.
11.  $P_D = (C_{PD} + C_X) V_{CC}^2 f_i \sum (C_L V_{CC}^2 f_O)$  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

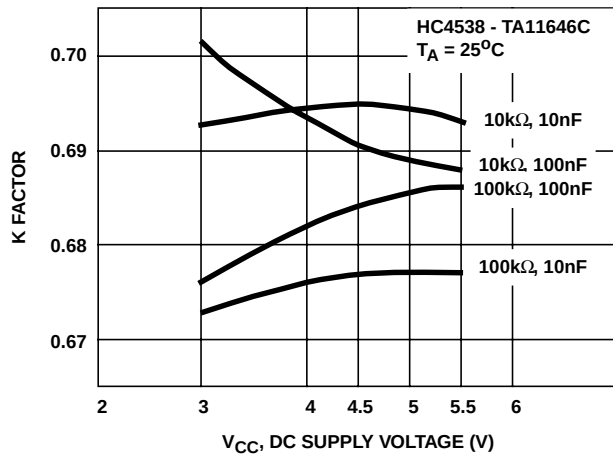


FIGURE 8. K FACTOR vs DC SUPPLY VOLTAGE ( $V_{CC}$ ) - V

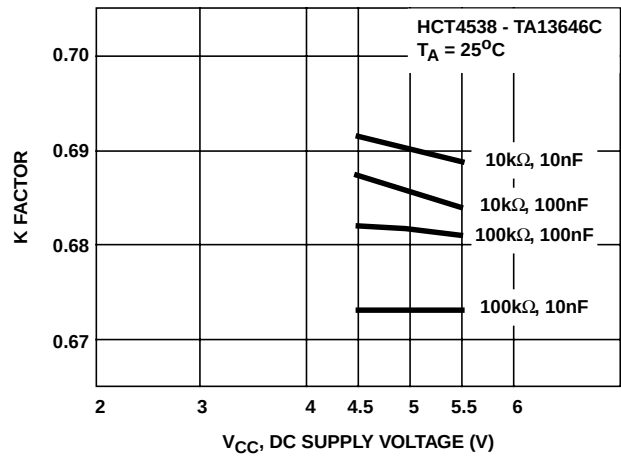


FIGURE 9. K FACTOR vs DC SUPPLY VOLTAGE ( $V_{CC}$ ) - V

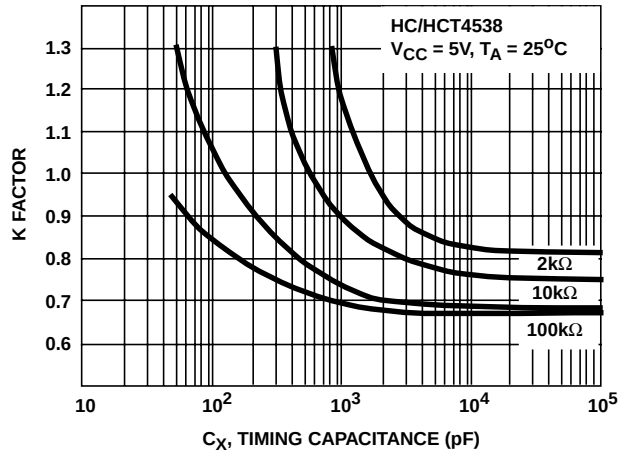


FIGURE 10. K FACTOR vs  $C_X$

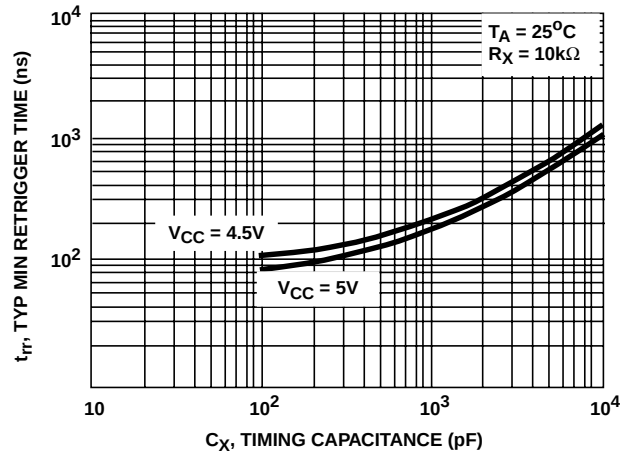


FIGURE 11. MINIMUM RETRIGGER TIME vs TIMING CAPACITANCE

## 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.

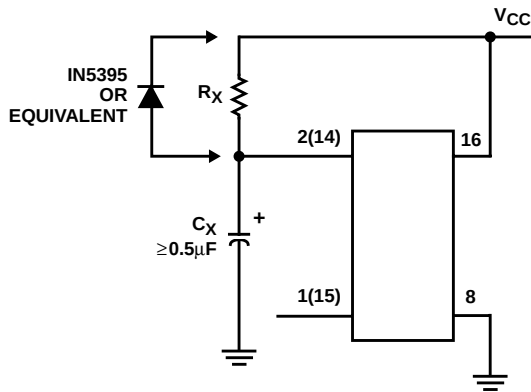


FIGURE 12. RAPID POWER-DOWN PROTECTION CIRCUIT

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.

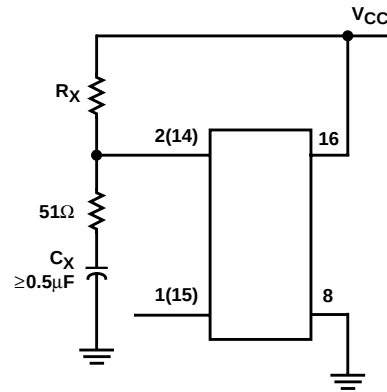


FIGURE 13. ALTERNATE RAPID POWER-DOWN PROTECTION CIRCUIT

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