

## CMOS Dual Precision Monostable Multivibrator

High-Voltage Types (20-Volt Rating)

**Features:**

- Retriggerable/resettable capability
- Trigger and reset propagation delays independent of  $R_x$ ,  $C_x$
- Triggering from leading or trailing edge
- Q and  $\bar{Q}$  buffered outputs available
- Separate resets
- Replaces CD4538B Type

■ CD14538B dual precision monostable multivibrator provides stable retriggerable/resettable one-shot operation for any fixed-voltage timing application.

An external resistor ( $R_x$ ) and an external capacitor ( $C_x$ ) control the timing and 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 time delay from trigger input to output transition (trigger propagation delay) and the time delay from reset input to output transition (reset propagation delay) are independent of  $R_x$  and  $C_x$ . Precision control of output pulse widths is achieved through linear CMOS techniques.

Leading-edge-triggering (+TR) and trailing-edge-triggering (-TR) inputs are provided for triggering from either edge of an input pulse. An unused +TR input should be tied to  $V_{SS}$ . An unused -TR input should be tied to  $V_{DD}$ . A RESET (on low level) is provided for immediate termination of the output pulse or to prevent output pulses when power is turned on. An unused RESET input should be tied to  $V_{DD}$ . However, if an entire section of the CD14538B is not used, its inputs must be tied to either  $V_{DD}$  or  $V_{SS}$ . See Table 1.

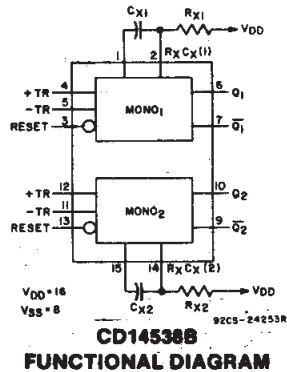
In normal operation the circuit retriggers (extends the output pulse one period) on the application of each new trigger pulse. For operation in the non-retriggerable mode,  $\bar{Q}$  is connected to -TR when leading-edge triggering (+TR) is used or Q is connected to +TR when trailing-edge triggering (-TR) is used. The time period (T) for this multivibrator can be calculated by:  $T = R_x C_x$ .

The minimum value of external resistance,  $R_x$ , is 4 k $\Omega$ . The minimum and maximum values of external capacitance,  $C_x$ , are 0 pF and 100  $\mu$ F, respectively.

The CD14538B types are supplied in 16-lead hermetic dual-in-line ceramic packages (D and F suffixes), 16-lead dual-in-line plastic packages (E suffix), and in chip form (H suffix).

The CD14538B is interchangeable with type MC14538 and is similar to and pin-compatible with the CD4098B\* and CD4538B. It can replace the CD4538B which type is not recommended for new designs.

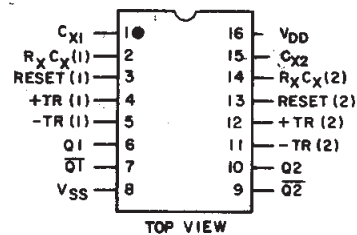
\* $T = 0.5 R_x C_x$  for  $C_x \geq 1000$  pF    # $T = R_x C_x$ ;  $C_{x\min} = 5000$  pF



- Wide range of output-pulse widths
- Schmitt-trigger input allows unlimited rise and fall times on +TR and -TR inputs
- 100% tested for maximum quiescent current at 20 V
- Maximum input current of 1  $\mu$ A at 18 V over full package-temperature range; 100 nA at 18 V and 25 $^{\circ}$ C
- Noise margin (full package-temperature range):
  - 1 V at  $V_{DD} = 5$  V
  - 2 V at  $V_{DD} = 10$  V
  - 2.5 V at  $V_{DD} = 15$  V
- 5-V, 10-V, and 15-V parametric ratings
- Standardized, symmetrical output characteristics
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices."

**Applications:**

- Pulse delay and timing
- Pulse shaping



TERMINALS 1, 8, 15 ARE  
ELECTRICALLY CONNECTED  
INTERNALLY

92CS-24848R1

**Terminal Assignment**

## CD14538B Types

### MAXIMUM RATINGS, Absolute-Maximum Values:

|  |  |  |               |
|--|--|--|---------------|
| DC SUPPLY-VOLTAGE RANGE, ( $V_{DD}$ )  | Voltages referenced to $V_{SS}$ Terminal | .....  | -0.5V to +20V |
| INPUT VOLTAGE RANGE, ALL INPUTS  | .....                                    | -0.5V to $V_{DD} + 0.5V$                     |               |
| DC INPUT CURRENT, ANY ONE INPUT  | .....                                    | $\pm 10mA$                                   |               |
| POWER DISSIPATION PER PACKAGE ( $P_D$ ):                                     |  |  |               |
| For $T_A = -55^\circ C$ to $+100^\circ C$                                    | .....                                    | 500mW  |               |
| For $T_A = +100^\circ C$ to $+125^\circ C$                                   | .....                                    | Derate Linearly at 12mW/ $^\circ C$ to 200mW |               |
| DEVICE DISSIPATION PER OUTPUT TRANSISTOR                                     |  |  |               |
| FOR $T_A =$ FULL PACKAGE-TEMPERATURE RANGE (All Package Types)               | .....                                    | 100mW  |               |
| OPERATING-TEMPERATURE RANGE ( $T_A$ )  | .....                                    | $-55^\circ C$ to $+125^\circ C$              |               |
| STORAGE TEMPERATURE RANGE ( $T_{stg}$ )                                      | .....                                    | $-65^\circ C$ to $+150^\circ C$              |               |
| LEAD TEMPERATURE (DURING SOLDERING):   |  |  |               |
| At distance $1/16 \pm 1/32$ inch ( $1.59 \pm 0.79mm$ ) from case for 10s max | .....                                    | $+265^\circ C$                               |               |

### RECOMMENDED OPERATING CONDITIONS

For maximum reliability, nominal operating conditions should be selected so that operating is always within the following ranges:

| CHARACTERISTIC   | $V_{DD}$<br>(V) | LIMITS |      | UNITS |
|--|-----------------|--------|------|-------|
|  |                 | Min.   | Max. |       |
| Supply-Voltage Range (For $T_A$ =Full Package-Temperature-Range) | —               | 3      | 18   | V     |
| Input Pulse Width<br>+TR, -TR, or RESET<br>$t_{WH}, t_{WL}$      | 5               | 140    | —    | ns    |
|  | 10              | 80     | —    |       |
|  | 15              | 60     | —    |       |

TABLE I  
CD4538B FUNCTIONAL TERMINAL CONNECTIONS

| FUNCTION                                    | $V_{DD}$ TO<br>TERM. NO. |                   | $V_{SS}$ TO<br>TERM. NO. |                   | INPUT PULSE<br>TO TERM. NO. |                   | 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 Trigger/<br>Retriggerable      | 3, 5                     | 11, 13            |                          |                   | 4                           | 12                |                      |                   |
| Leading-Edge Trigger/<br>Non-Retriggerable  | 3                        | 13                |                          |                   | 4                           | 12                | 5-7                  | 11-9              |
| Trailing-Edge Trigger/<br>Retriggerable     | 3                        | 13                | 4                        | 12                | 5                           | 11                |                      |                   |
| Trailing-Edge Trigger/<br>Non-Retriggerable | 3                        | 13                |                          |                   | 5                           | 11                | 4-6                  | 12-10             |

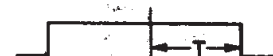
**NOTES:**

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-RETRIGGERABLE ONE-SHOT MULTIVIBRATOR HAS A TIME PERIOD (T) REFERENCED FROM THE APPLICATION OF THE FIRST TRIGGER PULSE.

INPUT PULSE TRAIN



RETRIGGERABLE MODE PULSE WIDTH (+TR MODE)



NON-RETRIGGERABLE MODE PULSE WIDTH (+TR MODE)



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# CD14538B Types

## STATIC ELECTRICAL CHARACTERISTICS

| CHARACTERISTIC                                     | CONDITIONS            |                        |                        | LIMITS AT INDICATED TEMPERATURES (°C) |       |       |       |       |                   |      | UNITS |
|--|-----------------------|------------------------|------------------------|---------------------------------------|-------|-------|-------|-------|-------------------|------|-------|
|  | V <sub>O</sub><br>(V) | V <sub>IN</sub><br>(V) | V <sub>DD</sub><br>(V) | -55                                   | -40   | +85   | +125  | Min.  | +25<br>Typ.       | Max. |       |
| Quiescent Device Current, I <sub>DD</sub> Max.     | —                     | 0,5                    | 5                      | 5                                     | 5     | 150   | 150   | —     | 0.04              | 5    | μA    |
|  | —                     | 0,10                   | 10                     | 10                                    | 10    | 300   | 300   | —     | 0.04              | 10   |       |
|  | —                     | 0,15                   | 15                     | 20                                    | 20    | 600   | 600   | —     | 0.04              | 20   |       |
|  | —                     | 0,20                   | 20                     | 100                                   | 100   | 3000  | 3000  | —     | 0.08              | 100  |       |
| Output Low (Sink) Current, I <sub>OL</sub> Min.    | 0.4                   | 0,5                    | 5                      | 0.64                                  | 0.61  | 0.42  | 0.36  | 0.51  | 1                 | —    | mA    |
|  | 0.5                   | 0,10                   | 10                     | 1.6                                   | 1.5   | 1.1   | 0.9   | 1.3   | 2.6               | —    |       |
|  | 1.5                   | 0,15                   | 15                     | 4.2                                   | 4     | 2.8   | 2.4   | 3.4   | 6.8               | —    |       |
| Output High (Source) Current, I <sub>OH</sub> Min. | 4.6                   | 0,5                    | 5                      | -0.64                                 | -0.61 | -0.42 | -0.36 | -0.51 | -1                | —    | mA    |
|  | 2.5                   | 0,5                    | 5                      | -2                                    | -1.8  | -1.3  | -1.15 | -1.6  | -3.2              | —    |       |
|  | 9.5                   | 0,10                   | 10                     | -1.6                                  | -1.5  | -1.1  | -0.9  | -1.3  | -2.6              | —    |       |
| Output Voltage: Low-Level, V <sub>OL</sub> Max.    | —                     | 0,5                    | 5                      | 0.05                                  |       |       |       | —     | 0                 | 0.05 | V     |
|  | —                     | 0,10                   | 10                     | 0.05                                  |       |       |       | —     | 0                 | 0.05 |       |
|  | —                     | 0,15                   | 15                     | 0.05                                  |       |       |       | —     | 0                 | 0.05 |       |
| Output Voltage: High-Level, V <sub>OH</sub> Min.   | —                     | 0,5                    | 5                      | 4.95                                  |       |       |       | 4.95  | 5                 | —    | V     |
|  | —                     | 0,10                   | 10                     | 9.95                                  |       |       |       | 9.95  | 10                | —    |       |
|  | —                     | 0,15                   | 15                     | 14.95                                 |       |       |       | 14.95 | 15                | —    |       |
| Input Low Voltage, V <sub>IL</sub> Max.            | 0.5,4.5               | —                      | 5                      | 1.5                                   |       |       |       | —     | —                 | 1.5  | V     |
|  | 1,9                   | —                      | 10                     | 3                                     |       |       |       | —     | —                 | 3    |       |
|  | 1.5,13.5              | —                      | 15                     | 4                                     |       |       |       | —     | —                 | 4    |       |
| Input High Voltage, V <sub>IH</sub> Min.           | 0.5,4.5               | —                      | 5                      | 3.5                                   |       |       |       | 3.5   | —                 | —    | V     |
|  | 1,9                   | —                      | 10                     | 7                                     |       |       |       | 7     | —                 | —    |       |
|  | 1.5,13.5              | —                      | 15                     | 11                                    |       |       |       | 11    | —                 | —    |       |
| Input Current, I <sub>IN</sub> Max.                | —                     | 0,18                   | 18                     | ±0.1                                  | ±0.1  | ±1    | ±1    | —     | ±10 <sup>-5</sup> | ±0.1 | μA    |

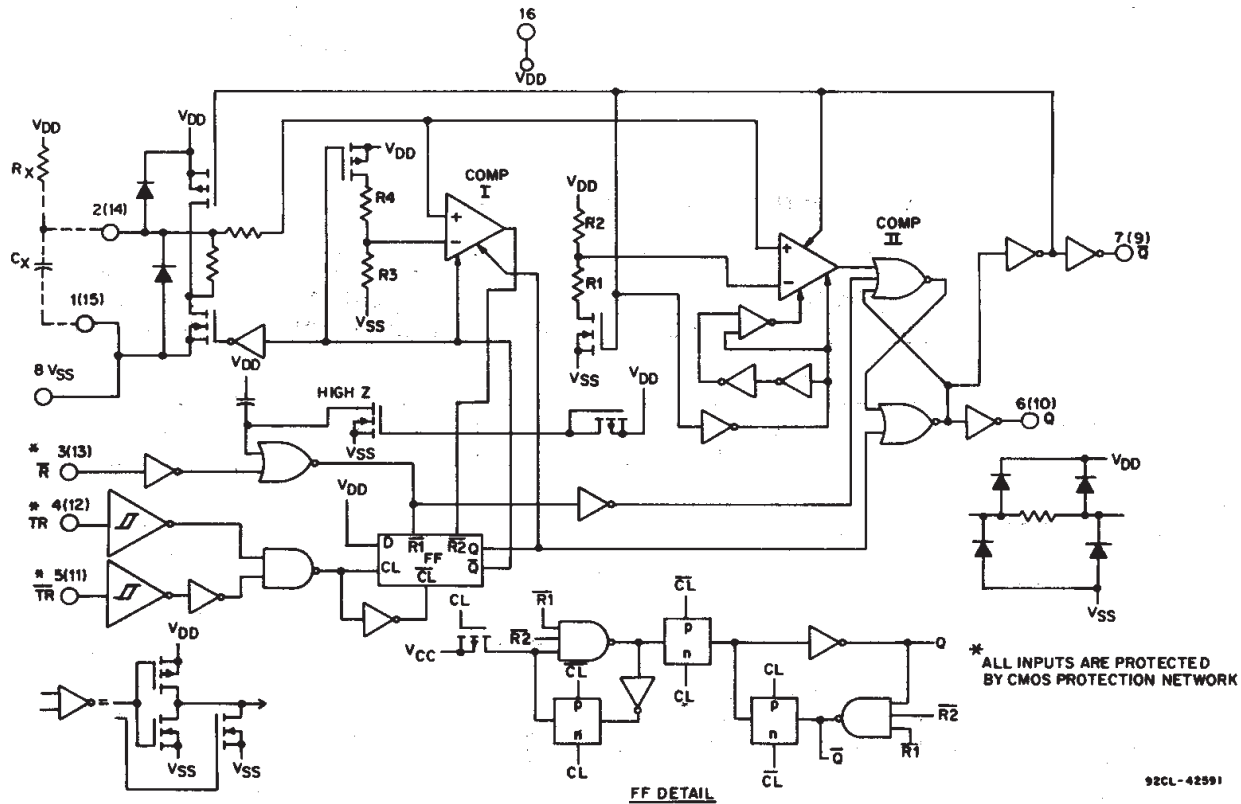


Fig. 1 - Logic diagram (1/2 of device shown).

# CD14538B Types

**DYNAMIC ELECTRICAL CHARACTERISTICS, At  $T_A=25^\circ\text{C}$ ; Input  $t_r, t_f=20\text{ ns}$ ,  $C_L=50\text{ pF}$**

| CHARACTERISTIC   | TEST CONDITIONS            | LIMITS       |      |         | UNITS |               |
|--|----------------------------|--------------|------|---------|-------|---------------|
|  |                            | $V_{DD}$ (V) | Min. | Typ.    |       | Max.          |
| Transition Time<br>$t_{TLH}, t_{THL}$  |                            | 5            | —    | 100     | 200   | ns            |
|  |                            | 10           | —    | 50      | 100   |               |
|  |                            | 15           | —    | 40      | 80    |               |
| Propagation Delay Time:<br>+TR or -TR to Q or $\bar{Q}$  | $t_{PLH}, t_{PHL}$         | 5            | —    | 300     | 600   | ns            |
|  |                            | 10           | —    | 150     | 300   |               |
|  |                            | 15           | —    | 100     | 220   |               |
| Reset to Q or $\bar{Q}$  |                            | 5            | —    | 250     | 500   | ns            |
|  |                            | 10           | —    | 125     | 250   |               |
|  |                            | 15           | —    | 95      | 190   |               |
| Minimum Input Pulse Width:<br>+TR, -TR or Reset  | $t_{WH}, t_{WL}$           | 5            | —    | 80      | 140   | ns            |
|  |                            | 10           | —    | 40      | 80    |               |
|  |                            | 15           | —    | 30      | 60    |               |
| Output Pulse Width - Q or $\bar{Q}$ :<br>$C_x = 0.002\ \mu\text{F}$ , $R_x = 100\ \text{K}\Omega$            | T                          | 5            | 198  | 210     | 230   | $\mu\text{s}$ |
|  |                            | 10           | 200  | 212     | 232   |               |
|  |                            | 15           | 202  | 214     | 234   |               |
| $C_x=0.1\ \mu\text{F}$ , $R_x=100\ \text{K}\Omega$   |                            | 5            | 9.4  | 9.97    | 10.5  | ms            |
|  |                            | 10           | 9.4  | 9.95    | 10.6  |               |
|  |                            | 15           | 9.5  | 10      | 10.6  |               |
| $C_x=10\ \mu\text{F}$ , $R_x=100\ \text{K}\Omega$  |                            | 5            | 0.95 | 1       | 1.06  | s             |
|  |                            | 10           | 0.95 | 1       | 1.06  |               |
|  |                            | 15           | 0.96 | 1.01    | 1.07  |               |
| Pulse Width Match between<br>circuits in same package:<br>$C_x=0.1\ \mu\text{F}$ , $R_x=100\ \text{K}\Omega$ | $\frac{100(T_1-T_2)}{T_1}$ | 5            | —    | $\pm 1$ | —     | %             |
|  |                            | 10           | —    | $\pm 1$ | —     |               |
|  |                            | 15           | —    | $\pm 1$ | —     |               |
| Minimum Retrigger Time   | $t_r$                      | 5            | 0    | —       | —     | ns            |
|  |                            | 10           | 0    | —       | —     |               |
|  |                            | 15           | 0    | —       | —     |               |
| Input Capacitance  | $C_{IN}$                   | Any Input    | —    | 5       | 7.5   | pF            |

\*Note: Minimum  $R_x$  value=4 K $\Omega$ , minimum  $C_x$  value=5000 pF.

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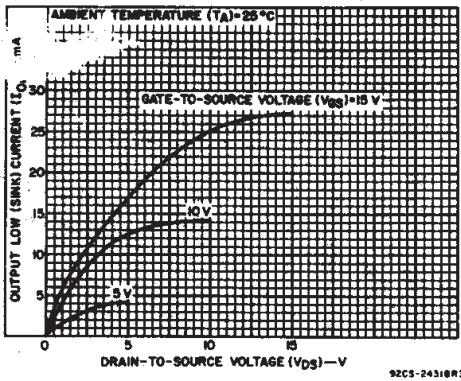


Fig. 2 - Typical output low (sink) current characteristics.

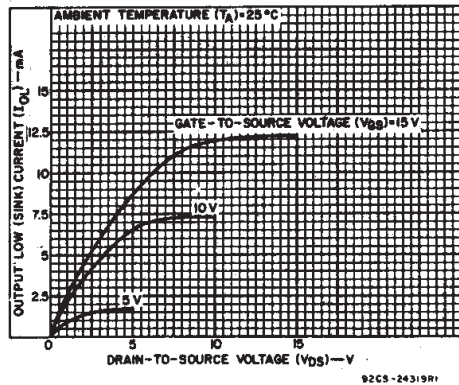


Fig. 3 - Minimum output low (sink) current characteristics.

# CD14538B Types

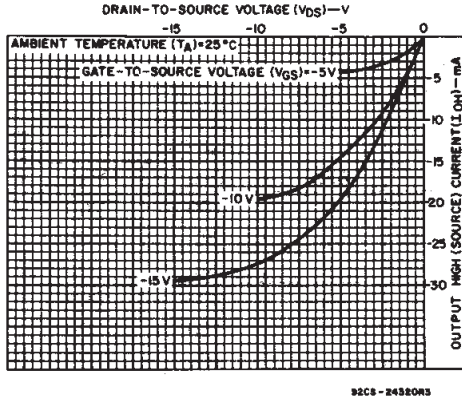


Fig. 4 - Typical output high (source) current characteristics.

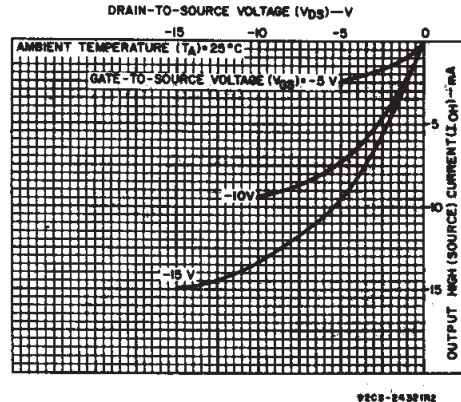


Fig. 5 - Minimum output high (source) current characteristics.

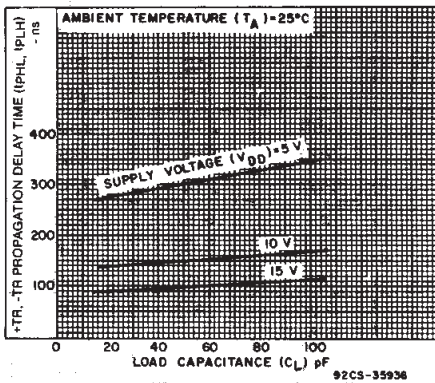


Fig. 6 - Typical propagation delay time as a function of load capacitance (+TR or -TR to Q or  $\bar{Q}$ ).

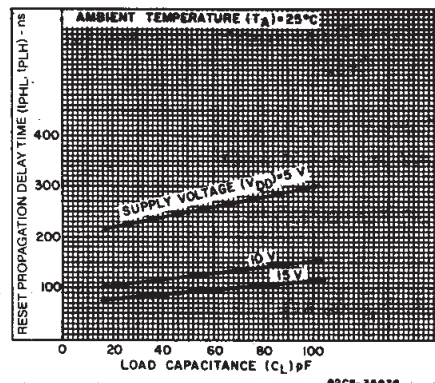


Fig. 7 - Typical propagation delay time as a function of load capacitance (RESET to Q or  $\bar{Q}$ ).

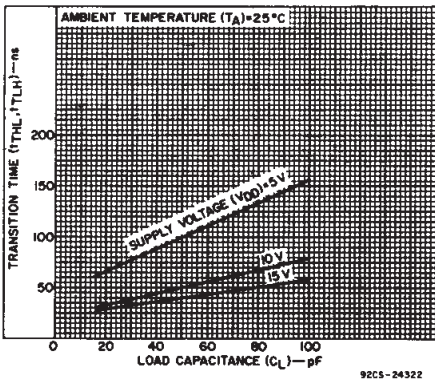


Fig. 8 - Typical transition time as a function of load capacitance.

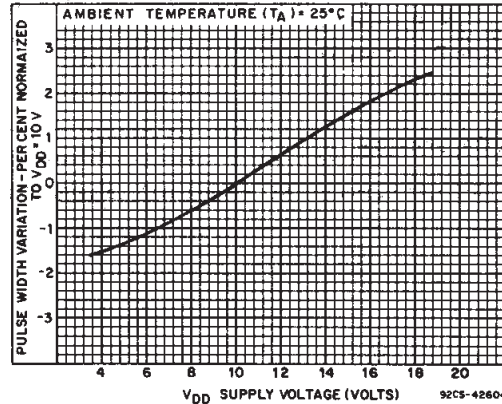


Fig. 9 - Typical pulse-width variation as a function of supply voltage.

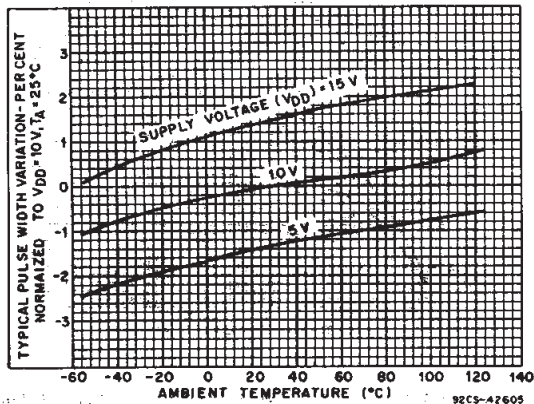


Fig. 10 - Typical pulse-width variation as a function of temperature ( $R_x=100\text{ K}\Omega$ ,  $C_x=0.1\text{ }\mu\text{F}$ ).

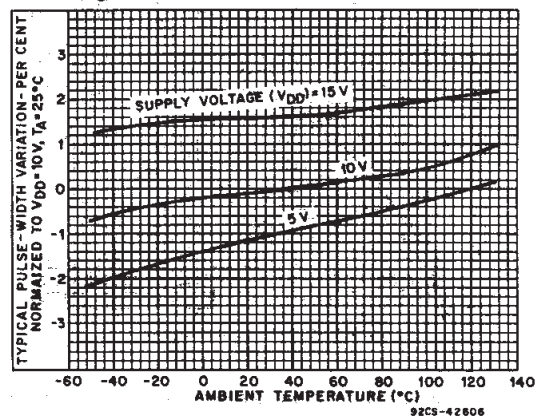


Fig. 11 - Typical pulse-width variation as a function of temperature ( $R_x=100\text{ K}\Omega$ ,  $C_x=2000\text{ pF}$ ).

## CD14538B Types

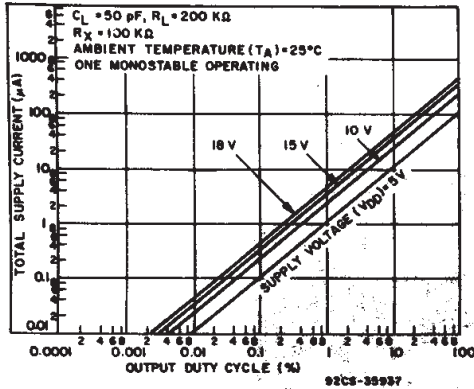


Fig. 12 - Typical total supply current as a function of output duty cycle.

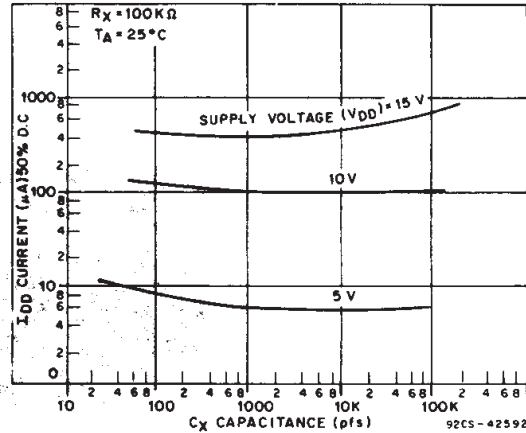
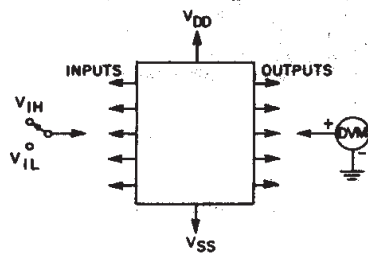


Fig. 13 - Typical total supply current as a function of load capacitance.



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Fig. 14 - Input voltage test circuit.

### NOTE:

1. Test any combination of inputs.
2. When measuring  $V_{IH}$  or  $V_{IL}$  for Schmitt trigger inputs (+TR, -TR), the input must first be brought to  $V_{DD}$  or  $V_{SS}$ , respectively, then reduced to the specified limit.

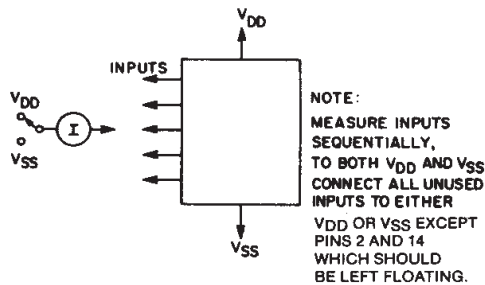


Fig. 15 - Input leakage-current test circuit.

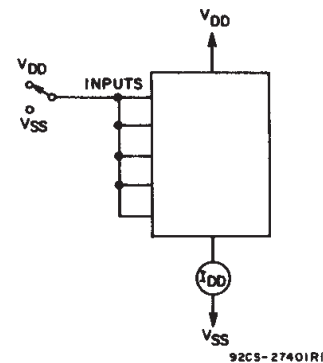


Fig. 16 - Quiescent device current test circuit.

### Power-Down Mode

During a rapid power-down condition, as would occur with a power-supply short circuit or 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  $\geq 0.5$  microfarad, 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 Fig. 17.

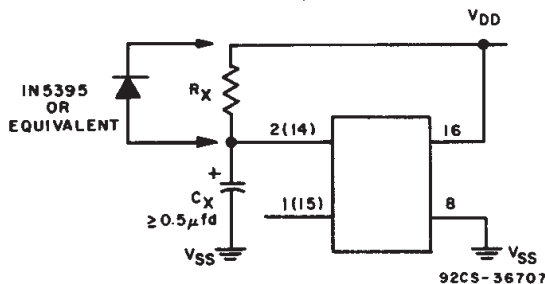


Fig. 17 - Rapid power-down protection circuit.

An alternate protection method is shown in Fig. 18, where a 51-ohm 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.

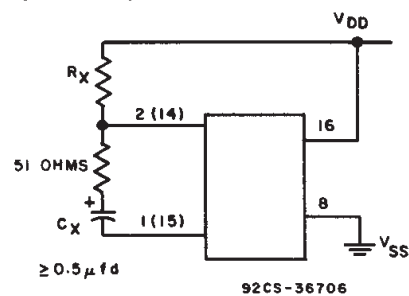
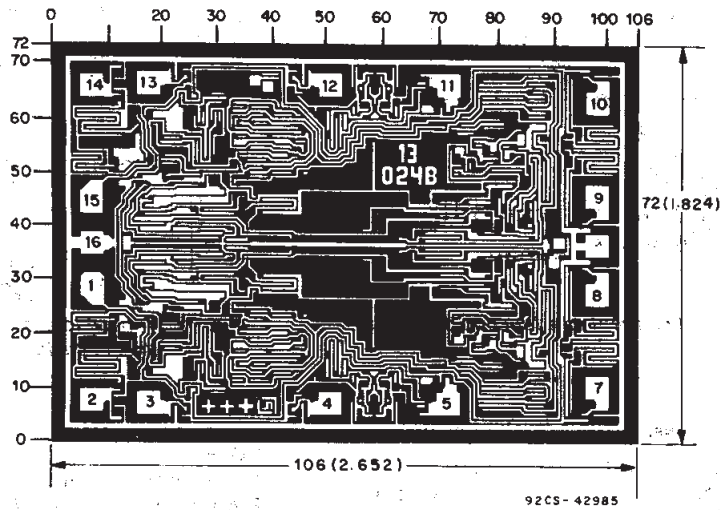


Fig. 18 - Alternate rapid power-down protection circuit.

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# CD14538B Types



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch).

Dimensions and pad layout for CD14538BH.

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