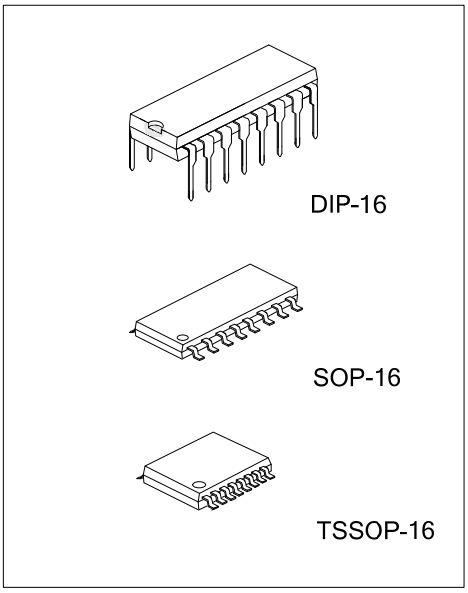
# UCD4060B

**CMOS IC**

## CMOS 14-STAGE RIPPLE-CARRY BINARY COUNTER/DIVIDER AND OSCILLATOR




### ■ DESCRIPTION

**UCD4060B** consists of an oscillator section and 14 ripple-carry binary counter stages. The oscillator configuration allows design of either $R_C$ or crystal oscillator circuits. A RESET input is provided which resets the counter to the all-O's state and disables the oscillator. A high level on the RESET line accomplishes the reset function. All counter stages are master-slave flip-flops. The state of the counter is advanced one step in binary order on the negative transition of ΦI and ΦO. All inputs and outputs are fully buffered. Schmitt trigger action on the input-pulse line permits unlimited input-pulse rise and fall times.

### ■ FEATURES

* 12MHz clock rate at 15V
* Common reset
* Fully static operation
* Buffered inputs and outputs
* Schmitt trigger input-pulse line

### ■ OSCILLATOR FEATURES

* All active components on chip
* RC or crystal oscillator configuration
* RC oscillator frequency of 690 kHz min. at 15V

### ■ APPLICATIONS

* Control counters
* Timers
* Frequency dividers
* Time-delay circuits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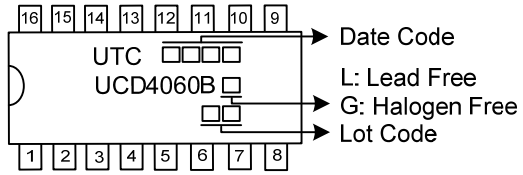
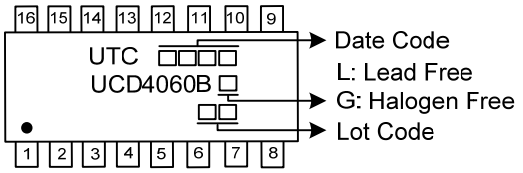
## ■ ORDERING INFORMATION

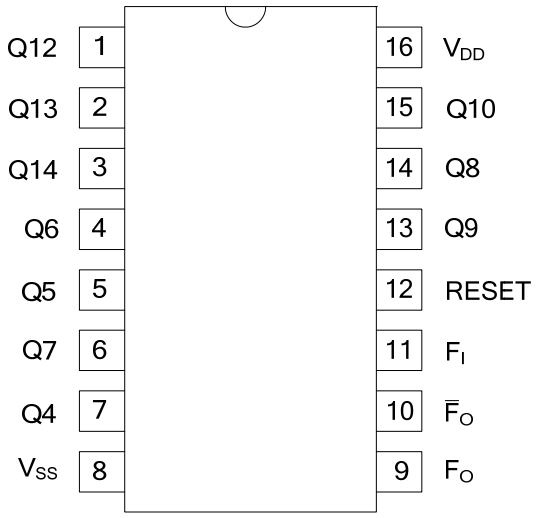
| Ordering Number | | Package | Packing |
|---|---|---|---|
| Lead Free | Halogen Free | | |
| UCD4060BL-D16-T | UCD4060BG-D16-T | DIP-16 | Tube |
| UCD4060BL-S16-R | UCD4060BG-S16-R | SOP-16 | Tape Reel |
| UCD4060BL-P16-R | UCD4060BG-P16-R | TSSOP-16 | Tape Reel |

| | |
|---|---|
| UCD4060BG-D16-T<br>(1)Packing Type<br>(2)Package Type<br>(3)Green Package | (1) T: Tube, R: Tape Reel<br>(2) D16: DIP-16, S16: SOP-16, P16: TSSOP-16<br>(3) G: Halogen Free and Lead Free, L: Lead Free |

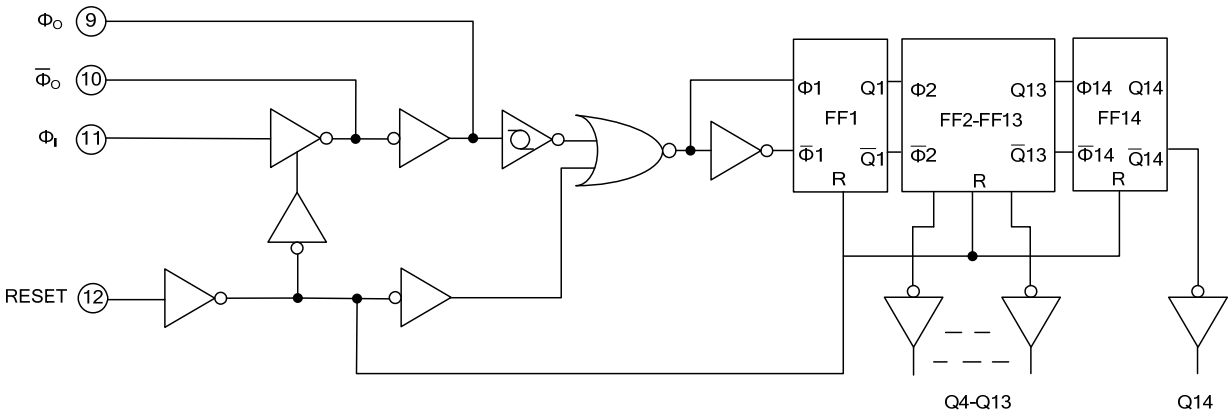
## ■ MARKING

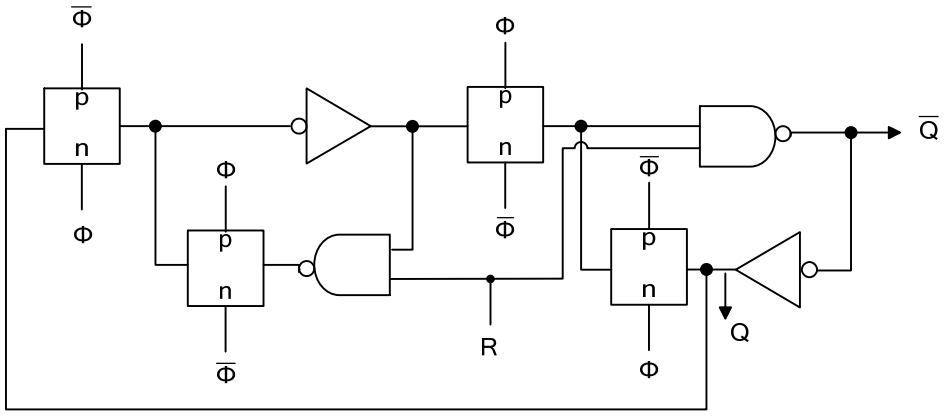
| DIP-16 | SOP-16 / TSSOP-16 |
|---|---|
|  |  |

## ■ PIN CONFIGURATION




## ■ LOGIC DIAGRAM



## ■ ABSOLUTE MAXIMUM RATING (Unless otherwise specified)

| PARAMETER | SYMBOL | RATINGS | UNIT |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | -0.5 ~ 20 | V |
| Input Voltage | $V_{IN}$ | -0.5 ~ $V_{CC}$+0.5 | V |
| Output Voltage | $V_{OUT}$ | -0.5 ~ $V_{CC}$+0.5 | V |
| Input Clamp Current ($V_{IN}$<0, or $V_{IN}$>$V_{DD}$) | $I_{IK}$ | ±10 | mA |
| Power Dissipation ($T_A$=-40°C~+125°C) | $P_D$ | 500 | mW |
| Storage Temperature | $T_{STG}$ | -65 ~ +150 | °C |

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.
2. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

## ■ RECOMMENDED OPERATING COMDITIONS

| PARAMETER | SYMBOL | CONDITIONS | MIN | TPY | MAX | UNIT |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | | 3 | | 18 | V |
| Input-Pulse Width | $t_W$ | $V_{DD}$=5V | 100 | | | ns |
| | | $V_{DD}$=10V | 40 | | | ns |
| | | $V_{DD}$=15V | 30 | | | ns |
| Input-Pulse Frequency | fφI | $V_{DD}$=5V | | | 3.5 | MHz |
| | | $V_{DD}$=10V | | | 8 | MHz |
| | | $V_{DD}$=15V | | | 12 | MHz |
| Input-Pulse Rise and Fall Time | $t_r$ / $t_f$ | $V_{DD}$=5V | Unlimited | | | μs |
| | | $V_{DD}$=10V | | | | μs |
| | | $V_{DD}$=15V | | | | μs |
| Reset Pulse Width | $t_W$ | $V_{DD}$=5V | 120 | | | ns |
| | | $V_{DD}$=10V | 60 | | | ns |
| | | $V_{DD}$=15V | 40 | | | ns |
| Operating Temperature | $T_A$ | | -40 | | +125 | °C |

## ■ THERMAL DATA

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Junction to Ambient | DIP-16 | $θ_{JA}$ | 69 | °C/W |
| | SOP-16 | | 90 | °C/W |
| | TSSOP-16 | | 110 | °C/W |

## ■ ELECTRICAL CHARACTERISTICS (Unless otherwise specified)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TPY | MAX | UNIT |
|---|---|---|---|---|---|---|
| Quiescent Supply Current | $I_{CC}$ | $V_{IN}$=0, 5V, $V_{DD}$=5V | | 0.04 | 5 | μA |
| | | $V_{IN}$=0, 10V, $V_{DD}$=10V | | 0.04 | 10 | |
| | | $V_{IN}$=0, 15V, $V_{DD}$=15V | | 0.04 | 20 | |
| | | $V_{IN}$=0, 20V, $V_{DD}$=20V | | 0.08 | 100 | |
| Output Low (Sink) Current | $I_{OL}$ | $V_{OUT}$=0.4V, $V_{IN}$=0, 5V, $V_{DD}$=5V | 0.51 | 1 | | mA |
| | | $V_{OUT}$=0.5V, $V_{IN}$=0, 10V, $V_{DD}$=10V | 1.3 | 2.6 | | |
| | | $V_{OUT}$=1.5V, $V_{IN}$=0, 15V, $V_{DD}$=15V | 3.4 | 6.8 | | |
| Output High (Source) Current | $I_{OH}$ | $V_{OUT}$=4.6V, $V_{IN}$=0, 5V, $V_{DD}$=5V | -0.51 | -1 | | mA |
| | | $V_{OUT}$=2.5V, $V_{IN}$=0, 5V, $V_{DD}$=5V | -1.6 | -3.2 | | |
| | | $V_{OUT}$=9.5V, $V_{IN}$=0, 10V, $V_{DD}$=10V | -1.3 | -2.6 | | |
| | | $V_{OUT}$=13.5V, $V_{IN}$=0, 15V, $V_{DD}$=15V | -3.4 | -6.8 | | |
| Output Voltage: Low-Level | $V_{OL}$ | $V_{IN}$= 0, 5V, $V_{DD}$=5V | | 0 | 0.05 | V |
| | | $V_{IN}$= 0, 10V, $V_{DD}$=10V | | 0 | 0.05 | |
| | | $V_{IN}$= 0, 15V, $V_{DD}$=15V | | 0 | 0.05 | |
| Output Voltage: High-Level | $V_{OH}$ | $V_{IN}$= 0, 5V, $V_{DD}$=5V | 4.95 | 5 | | V |
| | | $V_{IN}$= 0, 10V, $V_{DD}$=10V | 9.95 | 10 | | |
| | | $V_{IN}$= 0, 15V, $V_{DD}$=15V | 14.95 | 15 | | |
| Input Low Voltage | $V_{IL}$ | $V_{OUT}$=0.5, 4.5V, $V_{DD}$=5V | | | 1.5 | V |
| | | $V_{OUT}$=1, 9V, $V_{DD}$=10V | | | 3 | |
| | | $V_{OUT}$=1.5, 13.5V, $V_{DD}$=15V | | | 4 | |
| Input High Voltage | $V_{IH}$ | $V_{OUT}$=0.5, 4.5V, $V_{DD}$=5V | 3.5 | | | V |
| | | $V_{OUT}$=1, 9V, $V_{DD}$=10V | 7 | | | |
| | | $V_{OUT}$=1.5, 13.5V, $V_{DD}$=15V | 11 | | | |
| Input Leakage Current | $I_{I(LEAK)}$ | $V_{IN}$=0, 18V, $V_{DD}$=18V | | $\pm10^{-5}$ | ±0.1 | μA |

## ■ SWITCHING CHARACTERISTICS

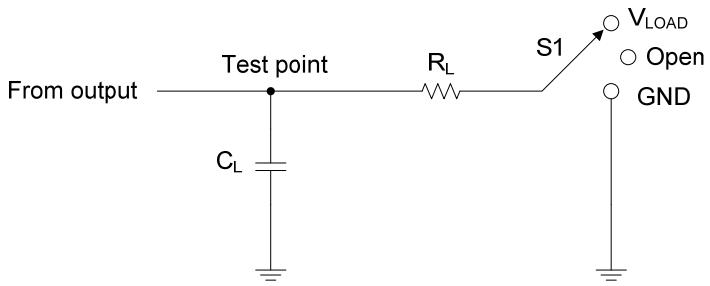
(UInput $t_r$ / $t_f$=20ns,$C_L$=50pF, $R_L$=200kΩ, Unless otherwise specified)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TPY | MAX | UNIT |
|---|---|---|---|---|---|---|
| **CLOCKED OPERATION** | | | | | | |
| Propagation Delay Time, ΦI to Q4 | $t_{PLH}$ / $t_{PHL}$ | $V_{DD}$=5V | | 370 | 740 | ns |
| | | $V_{DD}$=10V | | 150 | 300 | |
| | | $V_{DD}$=15V | | 100 | 200 | |
| Propagation Delay Time, Qn to Qn+1 | $t_{PLH}$ / $t_{PHL}$ | $V_{DD}$=5V | | 100 | 200 | ns |
| | | $V_{DD}$=10V | | 50 | 100 | |
| | | $V_{DD}$=15V | | 40 | 80 | |
| Transition Time | $t_{THL}$/ $t_{TLH}$ | $V_{DD}$=5V | | 100 | 200 | ns |
| | | $V_{DD}$=10V | | 50 | 100 | |
| | | $V_{DD}$=15V | | 40 | 80 | |
| Maximum Input-Pulse Frequency | f ΦI | $V_{DD}$=5V | 3.5 | 7 | | MHz |
| | | $V_{DD}$=10V | 8 | 16 | | |
| | | $V_{DD}$=15V | 12 | 24 | | |
| Minimum Input-Pulse Width | $t_W$ | $V_{DD}$=5V | | 50 | 100 | ns |
| | | $V_{DD}$=10V | | 20 | 40 | |
| | | $V_{DD}$=15 | | 15 | 30 | |
| Input-Pulse Rise and Fall Time | $t_r$ Φ/ $t_f$ Φ | $V_{DD}$=5V | Unlimited | | | |
| | | $V_{DD}$=10V | | | | |
| | | $V_{DD}$=15V | | | | |
| Average Input Capacitance | $C_I$ | Any Input | | 5 | 7.5 | pF |

■ SWITCHING CHARACTERISTICS (Cont.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TPY | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **RESET OPERATION** | | | | | | | |
| Propagation Delay Time | $t_{PLH}$ / $t_{PHL}$ | $V_{DD}$=5V | | | 180 | 360 | ns |
| | | $V_{DD}$=10V | | | 80 | 160 | ns |
| | | $V_{DD}$=15V | | | 50 | 100 | ns |
| Minimum Reset Pulse Width | $t_{WR}$ | $V_{DD}$=5V | | | 60 | 120 | ns |
| | | $V_{DD}$=10V | | | 30 | 60 | ns |
| | | $V_{DD}$=15 | | | 20 | 40 | ns |
| **RC OPERATION** | | | | | | | |
| Variation of Frequency | | $C_X$=200pF, $R_S$=560kΩ, $R_X$=50kΩ | $V_{DD}$=5V | | 23±10% | | kHz |
| | | | $V_{DD}$=10V | | 24±10% | | kHz |
| | | | $V_{DD}$=15V | | 25±10% | | kHz |
| Variation of Frequency with voltage change | | $C_X$=200pF, $R_S$=560kΩ, $R_X$=50kΩ | $V_{DD}$=5V~10V | | 1.5 | | kHz |
| | | | $V_{DD}$=10V~15V | | 0.5 | | kHz |
| $R_X$ max | | $C_X$=10Mf, $V_{DD}$=5V | | | | 20 | MΩ |
| | | $C_X$=50μF, $V_{DD}$=10V | | | | 20 | MΩ |
| | | $C_X$=10μF, $V_{DD}$=15V | | | | 10 | MΩ |
| $C_X$ max | | $R_X$=500kΩ, $V_{DD}$=5V | | | | 1000 | μF |
| | | $R_X$=300kΩ, $V_{DD}$=10V | | | | 50 | |
| | | $R_X$=300kΩ, $V_{DD}$=15V | | | | 50 | |
| Maximum Oscillator Frequency | | $C_X$=15pF, $R_S$=30kΩ, $R_X$=5kΩ | $V_{DD}$=10V | 530 | 650 | 810 | kHz |
| | | | $V_{DD}$=15 | 690 | 800 | 940 | kHz |
| Drive Current at Pin 9 | $I_{OL}$ | $V_O$=0.4V, $V_{DD}$=5V | | 0.16 | 0.35 | | mA |
| | | $V_O$=0.5V, $V_{DD}$=10V | | 0.42 | 0.8 | | mA |
| | | $V_O$=1.5V, $V_{DD}$=15 | | 1 | 2 | | mA |
| | $I_{OH}$ | $V_O$=4.6V, $V_{DD}$=5V | | -0.16 | -0.35 | | mA |
| | | $V_O$=9.5V, $V_{DD}$=10V | | -0.42 | -0.8 | | mA |
| | | $V_O$=13.5V, $V_{DD}$=15 | | -1 | -2 | | mA |

## ■ TEST CIRCUIT AND WAVEFORMS




| TEST | S1 |
|---|---|
| $t_{PLH}/t_{PHL}$ | GND |

**Fig. 1 Test Circuit**

| Inputs | | $V_M$ | $V_{LOAD}$ | $C_L$ | $R_L$ |
|---|---|---|---|---|---|
| $V_{IN}$ | $t_r$, $t_f$ | | | | |
| $V_{CC}$ | 20 ns | $V_{CC}/2$ | $V_{CC}$ | 50 pF | 200 KΩ |

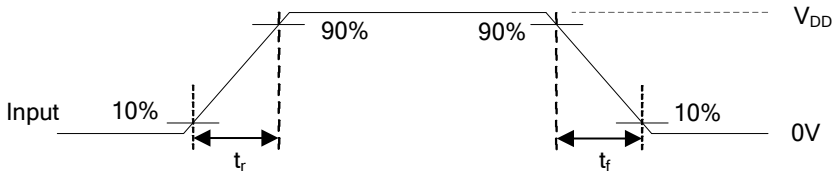



Fig. 2 Voltage Waveforms Input Rise And Fall Times

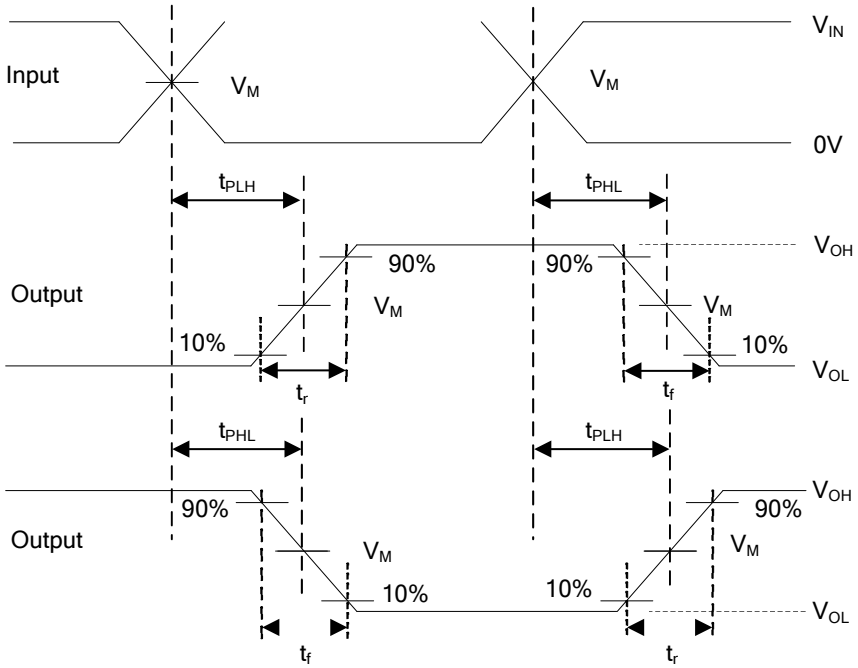



Fig. 3 Voltage Waveforms
Propagation Delay Aad Output Transition Times

Notes: 1. $C_L$ includes probe and jig capacitance.
2. All input pulses are supplied by generators having the following characteristics: PRR ≤1MHz, $Z_O$ = 50Ω.

■ TEST CIRCUIT AND WAVEFORMS (Cont.)

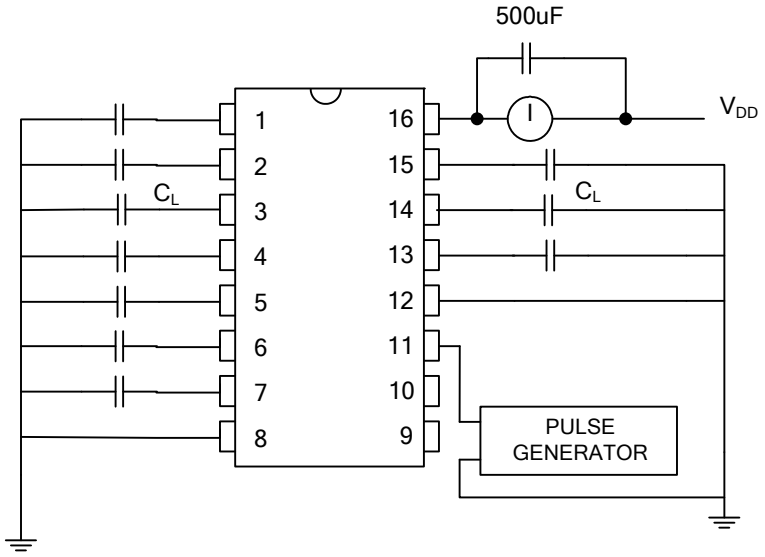



**Fig. 4 Dynamic Power Dissipation Test Circuit**

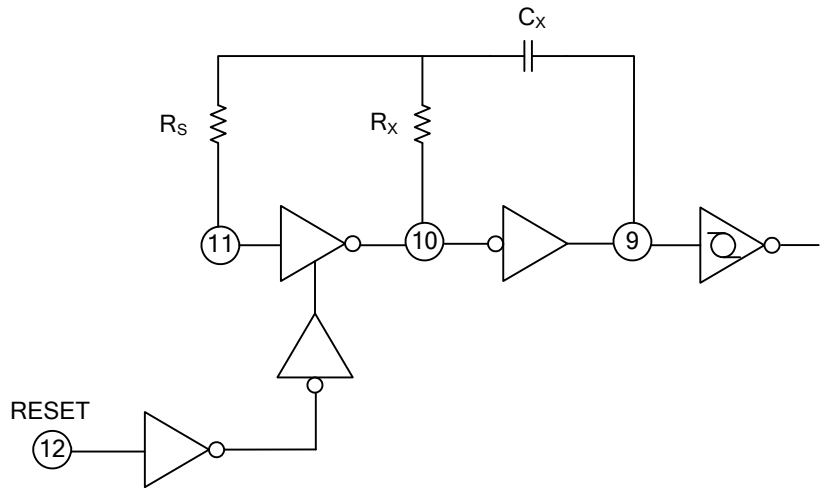



**Fig. 5 Typical RC Circuit**

■ TEST CIRCUIT AND WAVEFORMS (Cont.)

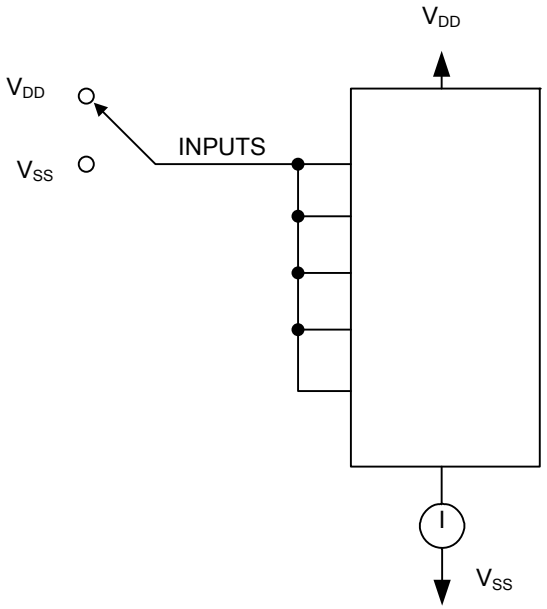



**Fig. 6 Quiescent device current test circuit**

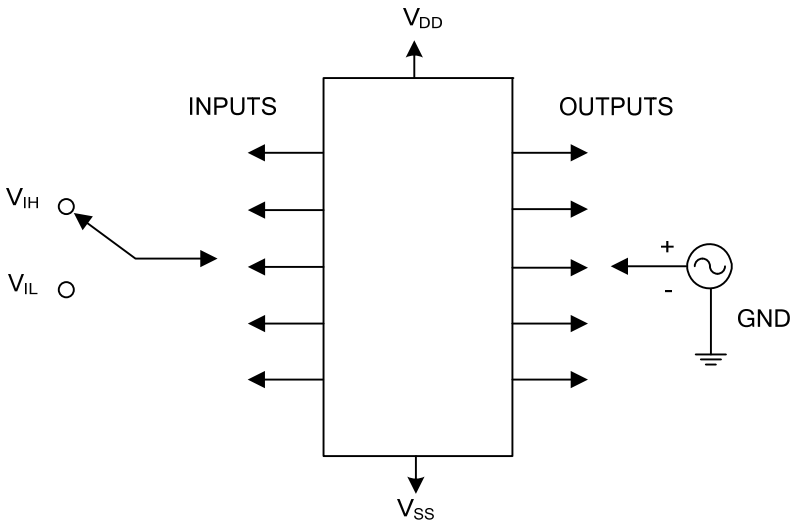



**Fig. 7 Input voltage test circuit**

## ■ TEST CIRCUIT AND WAVEFORMS (Cont.)

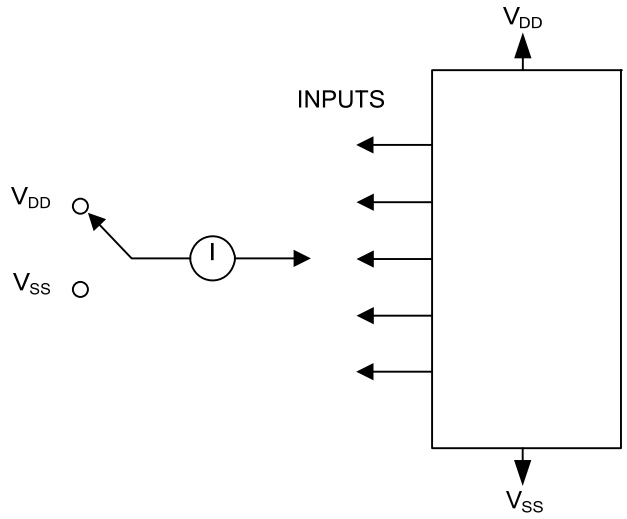



**Fig. 8 Input current test circuit**

Note：Measure inputs sequentially, to both $V_{DD}$ and $V_{SS}$; Connect all unused inputs to either $V_{DD}$ or $V_{SS}$.

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