

MC14526B

Presettable 4-Bit Down Counters

The MC14526B binary counter is constructed with MOS P-channel and N-channel enhancement mode devices in a monolithic structure.

This device is presettable, cascadable, synchronous down counter with a decoded "0" state output for divide-by-N applications. In single stage applications the "0" output is applied to the Preset Enable input. The Cascade Feedback input allows cascade divide-by-N operation with no additional gates required. The Inhibit input allows disabling of the pulse counting function. Inhibit may also be used as a negative edge clock.

This complementary MOS counter can be used in frequency synthesizers, phase-locked loops, and other frequency division applications requiring low power dissipation and/or high noise immunity.

Features

- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Logic Edge-Clocked Design: Incremented on Positive Transition of Clock or Negative Transition of Inhibit
- Asynchronous Preset Enable
- Capable of Driving Two Low-Power TTL Loads or One Low-Power Schottky TTL Load Over the Rated Temperature Range
- These Devices are Pb-Free and are RoHS Compliant

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-------------------|------------------------|-------------|
| DC Supply Voltage Range | V_{DD} | -0.5 to +18.0 | V |
| Input or Output Voltage Range (DC or Transient) | V_{in}, V_{out} | -0.5 to $V_{DD} + 0.5$ | V |
| Input or Output Current (DC or Transient) per Pin | I_{in}, I_{out} | ± 10 | mA |
| Power Dissipation per Package (Note 1) | P_D | 500 | mW |
| Operating Temperature Range | T_A | -55 to +125 | $^{\circ}C$ |
| Storage Temperature Range | T_{stg} | -65 to +150 | $^{\circ}C$ |
| Lead Temperature (8-Second Soldering) | T_L | 260 | $^{\circ}C$ |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Temperature Derating:

Plastic "P and D/DW" Packages: - 7.0 mW/ $^{\circ}C$ From 65 $^{\circ}C$ To 125 $^{\circ}C$

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$.

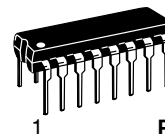
Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.



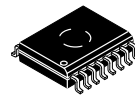
ON Semiconductor®

<http://onsemi.com>

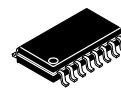
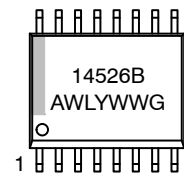
MARKING DIAGRAMS



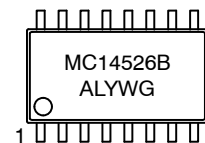
PDIP-16
P SUFFIX
CASE 648



SOIC-16 WB
DW SUFFIX
CASE 751G



SOEIAJ-16
F SUFFIX
CASE 966



A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week
G = Pb-Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

FUNCTION TABLE

| Inputs | | | | | Output | Resulting Function |
|--------|-------|---------|---------------|------------------|--------|-----------------------------|
| Clock | Reset | Inhibit | Preset Enable | Cascade Feedback | "0" | |
| X | H | X | L | L | L | Asynchronous reset* |
| X | H | X | H | L | H | Asynchronous reset |
| X | H | X | X | H | H | Asynchronous reset |
| X | L | X | H | X | L | Asynchronous preset |
| L | L | H | L | X | L | Decrement inhibited |
| | | | L | X | L | Decrement inhibited |
| H | L | L | L | L | L | No change** (inactive edge) |
| | | | L | L | L | No change** (inactive edge) |
| | | | L | L | L | Decrement** |
| | | | L | L | L | Decrement** |

X = Don't Care

NOTES:

* Output "0" is low when reset goes high only if PE and CF are low.

** Output "0" is high when reset is low, only if CF is high and count is 0000.

PIN DESCRIPTIONS

Preset Enable (Pin 3) — If Reset is low, a high level on the Preset Enable input asynchronously loads the counter with the programmed values on P0, P1, P2, and P3.

Inhibit (Pin 4) — A high level on the Inhibit input prevents the Clock from decrementing the counter. With Clock (pin 6) held high, Inhibit may be used as a negative edge clock input.

Clock (Pin 6) — The counter decrements by one for each rising edge of Clock. See the Function Table for level requirements on the other inputs.

Reset (Pin 10) — A high level on Reset asynchronously forces Q0, Q1, Q2, and Q3 low and, if Cascade Feedback is high, causes the "0" output to go high.

"0" (Pin 12) — The "0" (Zero) output issues a pulse one clock period wide when the counter reaches terminal count (Q0 = Q1 = Q2 = Q3 = low) if Cascade Feedback is high and Preset Enable is low. When presetting the counter to a value

other than all zeroes, the "0" output is valid after the rising edge of Preset Enable (when Cascade Feedback is high). See the Function Table.

Cascade Feedback (Pin 13) — If the Cascade Feedback input is high, a high level is generated at the "0" output when the count is all zeroes. If Cascade Feedback is low, the "0" output depends on the Preset Enable input level. See the Function Table.

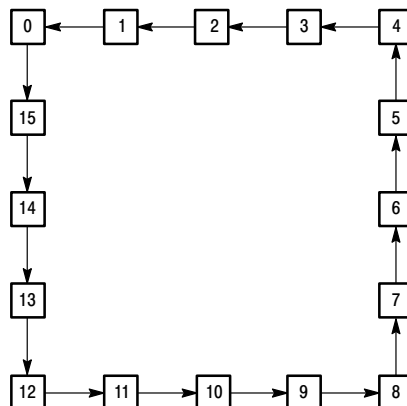
P0, P1, P2, P3 (Pins 5, 11, 14, 2) — These are the preset data inputs. P0 is the LSB.

Q0, Q1, Q2, Q3 (Pins 7, 9, 15, 1) — These are the synchronous counter outputs. Q0 is the LSB.

VSS (Pin 8) — The most negative power supply potential. This pin is usually ground.

VDD (Pin 16) — The most positive power supply potential. VDD may range from 3.0 to 18 V with respect to VSS.

STATE DIAGRAM
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ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

| Characteristic | Symbol | V _{DD} Vdc | -55°C | | 25°C | | | 125°C | | Unit | |
|---|--|------------------------|------------------------|-------------------------------|----------------------|-------------------------------|---|----------------------|-------------------------------|----------------------|------|
| | | | Min | Max | Min | Typ (Note 2) | Max | Min | Max | | |
| Output Voltage V _{in} = V _{DD} or 0 | "0" Level | V _{OL} | 5.0 10 15 | - - - | 0.05 0.05 0.05 | - - - | 0 0 0 | 0.05 0.05 0.05 | - - - | 0.05 0.05 0.05 | Vdc |
| | V _{in} = 0 or V _{DD} | "1" Level | | | | | | | | | |
| Output Voltage V _{in} = V _{DD} or 0 | "0" Level | V _{OH} | 5.0 10 15 | 4.95 9.95 14.95 | - - - | 4.95 9.95 14.95 | 5.0 10 15 | - - - | 4.95 9.95 14.95 | - - - | Vdc |
| | V _{in} = 0 or V _{DD} | "1" Level | | | | | | | | | |
| Input Voltage (V _O = 4.5 or 0.5 Vdc) (V _O = 9.0 or 1.0 Vdc) (V _O = 13.5 or 1.5 Vdc) | "0" Level | V _{IL} | 5.0 10 15 | - - - | 1.5 3.0 4.0 | - - - | 2.25 4.50 6.75 | 1.5 3.0 4.0 | - - - | 1.5 3.0 4.0 | Vdc |
| | (V _O = 0.5 or 4.5 Vdc) (V _O = 1.0 or 9.0 Vdc) (V _O = 1.5 or 13.5 Vdc) | "1" Level | | | | | | | | | |
| Input Voltage (V _O = 4.5 or 0.5 Vdc) (V _O = 9.0 or 1.0 Vdc) (V _O = 13.5 or 1.5 Vdc) | "0" Level | V _{IH} | 5.0 10 15 | 3.5 7.0 11 | - - - | 3.5 7.0 11 | 2.75 5.50 8.25 | - - - | 3.5 7.0 11 | - - - | Vdc |
| | (V _O = 0.5 or 4.5 Vdc) (V _O = 1.0 or 9.0 Vdc) (V _O = 1.5 or 13.5 Vdc) | "1" Level | | | | | | | | | |
| Output Drive Current (V _{OH} = 2.5 Vdc) (V _{OH} = 4.6 Vdc) (V _{OH} = 9.5 Vdc) (V _{OH} = 13.5 Vdc) | Source | I _{OH} | 5.0 5.0 10 15 | -3.0 -0.64 -1.6 -4.2 | - - - - | -2.4 -0.51 -1.3 -3.4 | -4.2 -0.88 -2.25 -8.8 | - - - - | -1.7 -0.36 -0.9 -2.4 | - - - - | mAdc |
| | (V _{OL} = 0.4 Vdc) (V _{OL} = 0.5 Vdc) (V _{OL} = 1.5 Vdc) | Sink | I _{OL} | 5.0 10 15 | 0.64 1.6 4.2 | - - - | 0.51 1.3 3.4 | 0.88 2.25 8.8 | - - - | 0.36 0.9 2.4 | |
| Input Current | | I _{in} | 15 | - | ±0.1 | - | ±0.00001 | ±0.1 | - | ±1.0 | μAdc |
| Input Capacitance (V _{in} = 0) | | C _{in} | - | - | - | - | 5.0 | 7.5 | - | - | pF |
| Quiescent Current (Per Package) | | | 5.0 | - | 5.0 | - | 0.005 | 5.0 | - | 150 | μAdc |
| | | | 10 | - | 10 | - | 0.010 | 10 | - | 300 | |
| | | | 15 | - | 20 | - | 0.015 | 20 | - | 600 | |
| Total Supply Current (Notes 3, 4) (Dynamic plus Quiescent, Per Package) (C _L = 50 pF on all outputs, all buffers switching) | | | 5.0 10 15 | | | | I _T = (1.7 μA/kHz) f + I _{DD} I _T = (3.4 μA/kHz) f + I _{DD} I _T = (5.1 μA/kHz) f + I _{DD} | | | | μAdc |

2. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

3. The formulas given are for the typical characteristics only at 25°C.

4. To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) Vfk$$

where: I_T is in μA (per package), C_L in pF, V = (V_{DD} - V_{SS}) in volts, f in kHz is input frequency, and k = 0.001.

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SWITCHING CHARACTERISTICS ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$) (Note 5)

| Characteristic | Symbol | V_{DD} | Min | Typ (Note 6) | Max | Unit |
|--|---|-----------------|-------------------|--------------------|--------------------|---------------|
| Output Rise and Fall Time t_{TLH} , $t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ t_{TLH} , $t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ t_{TLH} , $t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$ | t_{TLH} , t_{THL} (Figures 4, 5) | 5.0 10 15 | – – – | 100 50 40 | 200 100 80 | ns |
| Propagation Delay Time (Inhibit Used as Negative Edge Clock) Clock or Inhibit to Q t_{PLH} , $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 465 \text{ ns}$ t_{PLH} , $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 197 \text{ ns}$ t_{PLH} , $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 135 \text{ ns}$ Clock or Inhibit to "0" t_{PLH} , $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 155 \text{ ns}$ t_{PLH} , $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 87 \text{ ns}$ t_{PLH} , $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 65 \text{ ns}$ | t_{PLH} , t_{PHL} (Figures 4, 5, 6) | 5.0 10 15 | – – – | 550 225 160 | 1100 450 320 | ns |
| | | 5.0 10 15 | – – – | 240 130 100 | 480 260 200 | |
| Propagation Delay Time Pn to Q | t_{PLH} , t_{PHL} (Figures 4, 7) | 5.0 10 15 | – – – | 260 120 100 | 520 240 200 | |
| Propagation Delay Time Reset to Q | t_{PHL} (Figure 8) | 5.0 10 15 | – – – | 250 110 80 | 500 220 160 | ns |
| Propagation Delay Time Preset Enable to "0" | t_{PHL} , t_{PLH} (Figures 4, 9) | 5.0 10 15 | – – – | 220 100 80 | 440 200 160 | ns |
| Clock or Inhibit Pulse Width | t_w (Figures 5, 6) | 5.0 10 15 | 250 100 80 | 125 50 40 | – – – | ns |
| Clock Pulse Frequency (with PE = low) | f_{max} (Figures 4, 5, 6) | 5.0 10 15 | – – – | 2.0 5.0 6.6 | 1.5 3.0 4.0 | MHz |
| Clock or Inhibit Rise and Fall Time | t_r , t_f (Figures 5, 6) | 5.0 10 15 | – – – | – – – | 15 5 4 | μs |
| Setup Time Pn to Preset Enable | t_{su} (Figure 1) | 5.0 10 15 | 90 50 40 | 40 15 10 | – – – | ns |
| Hold Time Preset Enable to Pn | t_h (Figure 2) | 5.0 10 15 | 30 30 30 | –15 –5 0 | – – – | ns |
| Preset Enable Pulse Width | t_w (Figure 3) | 5.0 10 15 | 250 100 80 | 125 50 40 | – – – | ns |
| Reset Pulse Width | t_w (Figure 8) | 5.0 10 15 | 350 250 200 | 175 125 100 | – – – | ns |
| Reset Removal Time | t_{rem} (Figure 8) | 5.0 10 15 | 10 20 30 | –110 –30 –20 | – – – | ns |

5. The formulas given are for the typical characteristics only at 25°C .

6. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

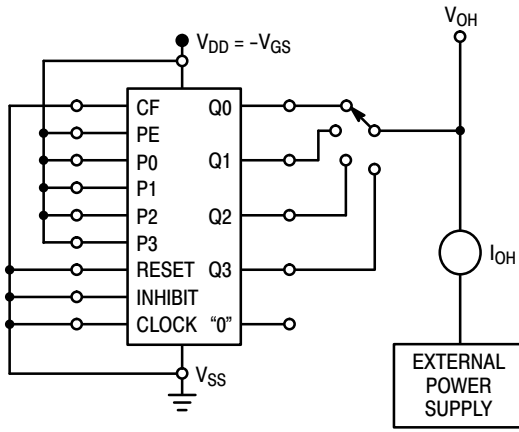


Figure 1. Typical Output Source Characteristics Test Circuit

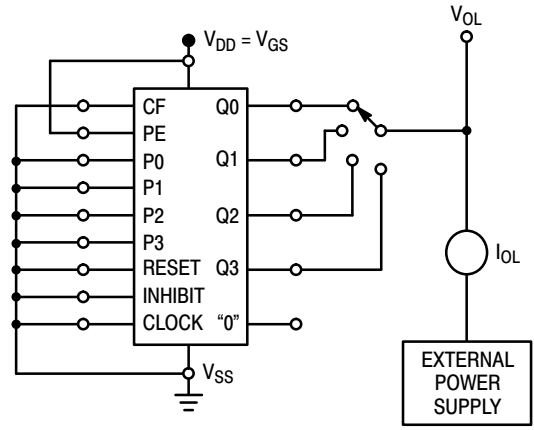


Figure 2. Typical Output Sink Characteristics Test Circuit

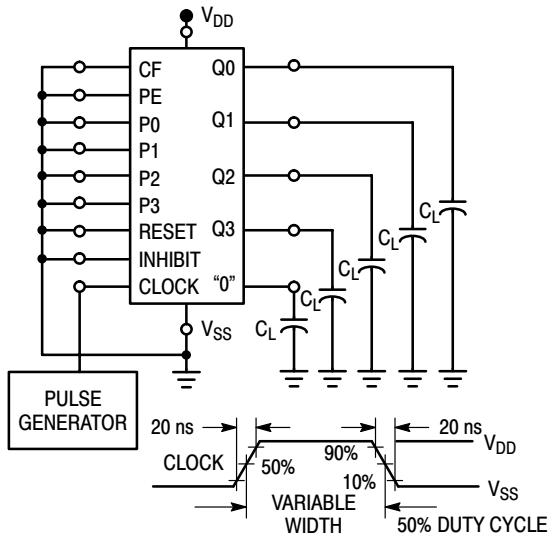
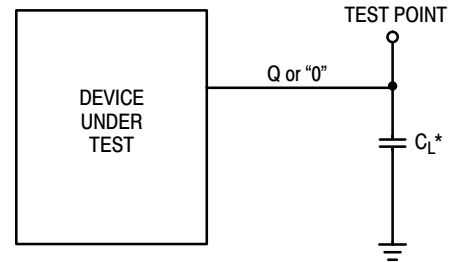


Figure 3. Power Dissipation



*Includes all probe and jig capacitance.

Figure 4. Test Circuit

SWITCHING WAVEFORMS

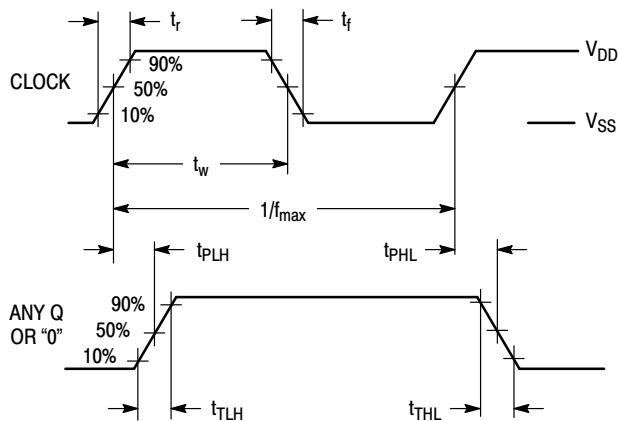


Figure 5.

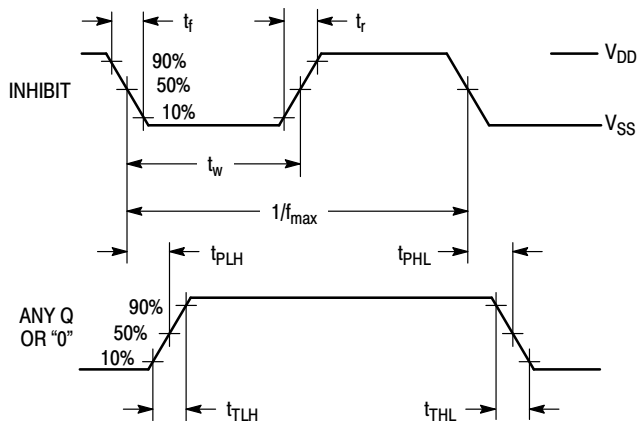


Figure 6.

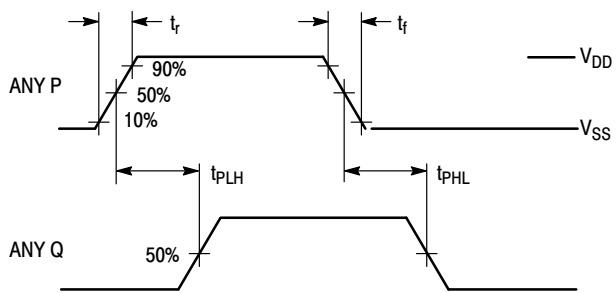


Figure 7.

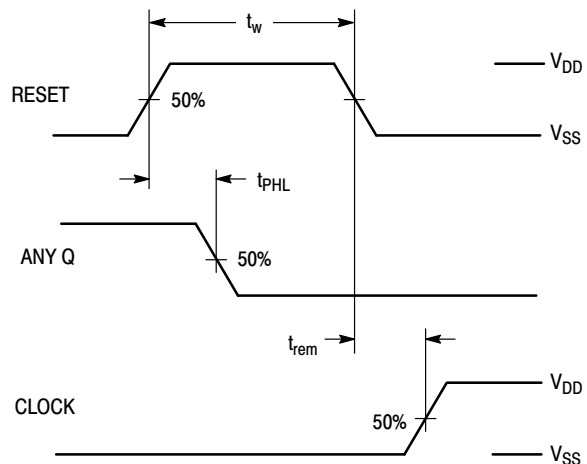


Figure 8.

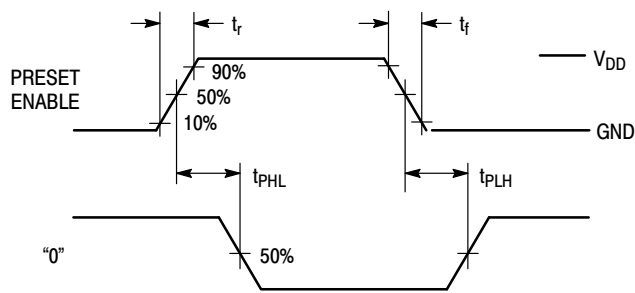


Figure 9.

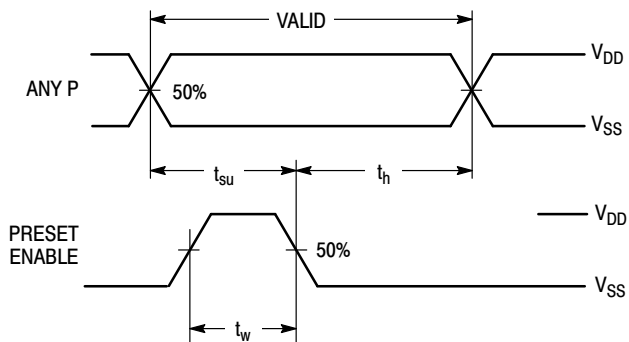
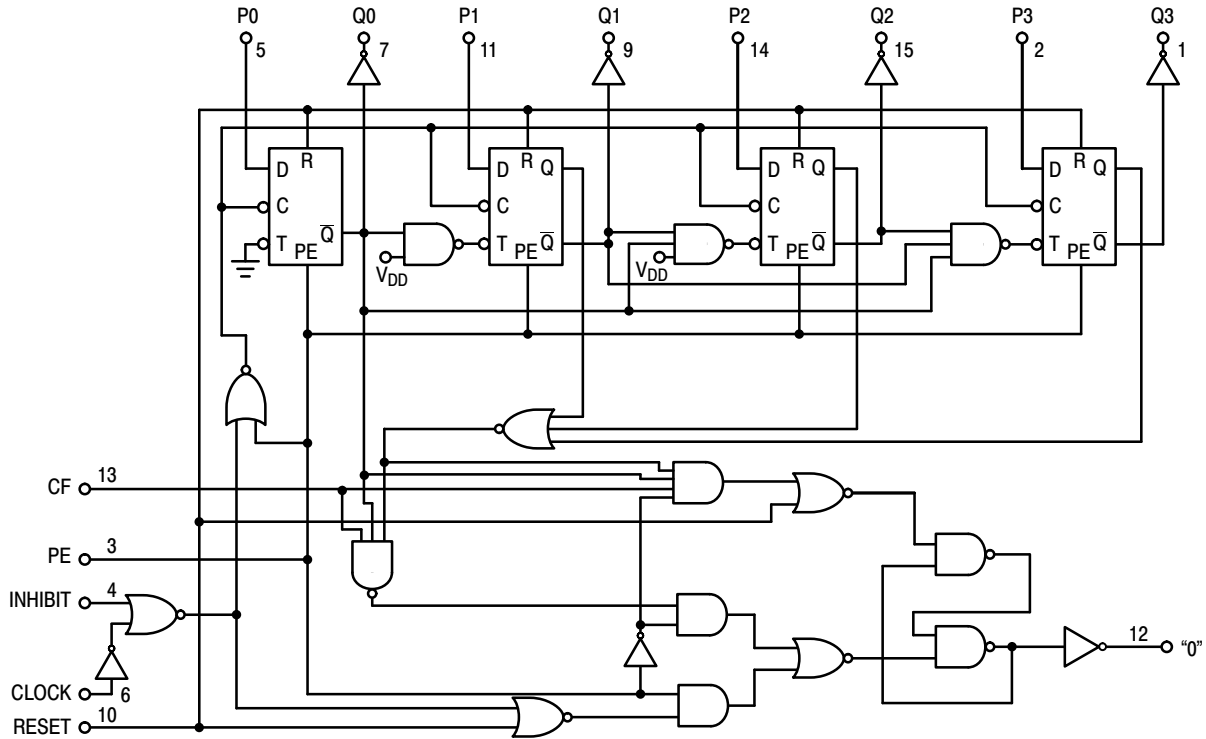


Figure 10.

MC14526B

MC14526B LOGIC DIAGRAM (Binary Down Counter)



APPLICATIONS INFORMATION

Divide-By-N, Single Stage

Figure 11 shows a single stage divide-by-N application.

To initialize counting a number, N is set on the parallel inputs (P0, P1, P2, and P3) and reset is taken high asynchronously. A zero is forced into the master and slave of each bit and, at the same time, the "0" output goes high. Because Preset Enable is tied to the "0" output, preset is enabled. Reset must be released while the Clock is high so the slaves of each bit may receive N before the Clock goes low. When the Clock goes low and Reset is low, the "0" output goes low (if P0 through P3 are unequal to zero).

The counter downcounts with each rising edge of the Clock. When the counter reaches the zero state, an output pulse occurs on "0" which presets N. The propagation delays from the Clock's rising and falling edges to the "0" output's rising and falling edges are about equal, making the "0" output pulse approximately equal to that of the Clock pulse.

The Inhibit pin may be used to stop pulse counting. When this pin is taken high, decrementing is inhibited.

Cascaded, Presetable Divide-By-N

Figure 12 shows a three stage cascade application. Taking Reset high loads N. Only the first stage's Reset pin (least significant counter) must be taken high to cause the preset for all stages, but all pins could be tied together, as shown.

When the first stage's Reset pin goes high, the "0" output is latched in a high state. Reset must be released while Clock is high and time allowed for Preset Enable to load N into all stages before Clock goes low.

When Preset Enable is high and Clock is low, time must be allowed for the zero digits to propagate a Cascade Feedback to the first non-zero stage. Worst case is from the most significant bit (M.S.B.) to the L.S.B., when the L.S.B. is equal to one (i.e. N = 1).

After N is loaded, each stage counts down to zero with each rising edge of Clock. When any stage reaches zero and the leading stages (more significant bits) are zero, the "0" output goes high and feeds back to the preceding stage. When all stages are zero, the Preset Enable automatically loads N while the Clock is high and the cycle is renewed.

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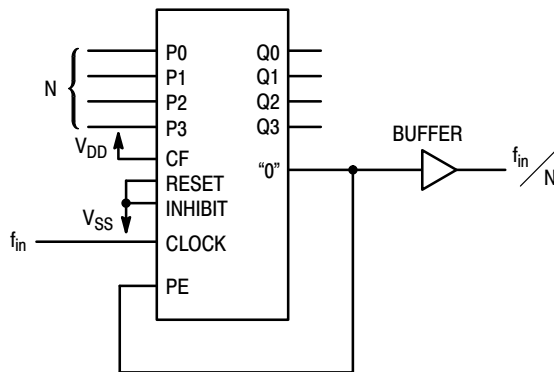


Figure 11. ÷ N Counter

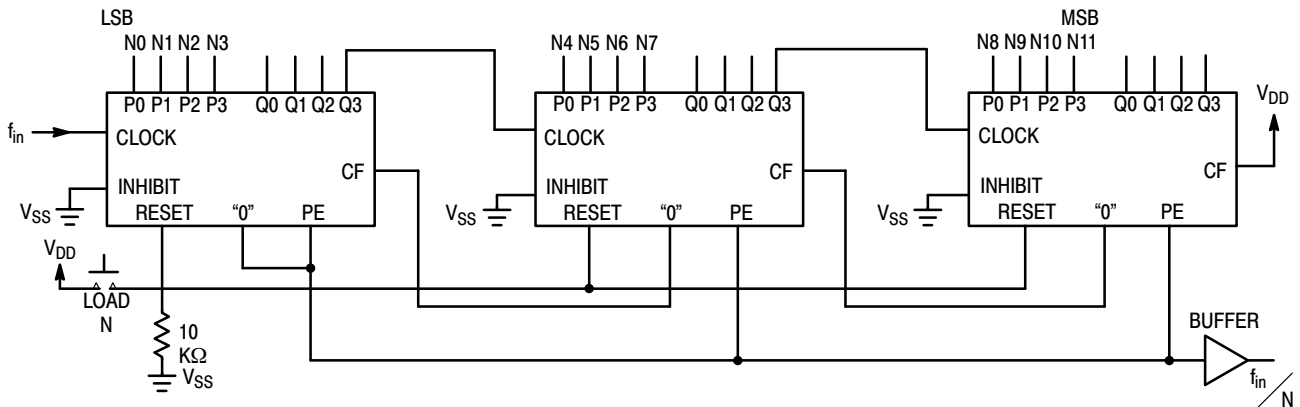


Figure 12. 3 Stages Cascaded

ORDERING INFORMATION

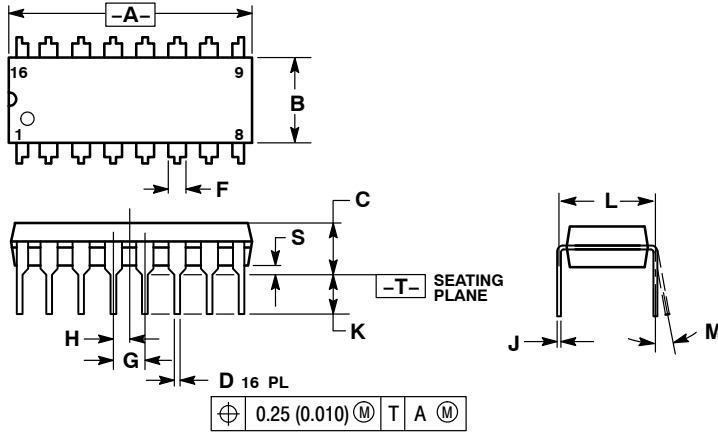
| Device | Package | Shipping† |
|---------------|------------------------|--------------------|
| MC14526BCPG | PDIP-16 (Pb-Free) | 500 Units / Rail |
| MC14526BDWG | SOIC-16 (Pb-Free) | 47 Units / Rail |
| MC14526BDWR2G | SOIC-16 (Pb-Free) | 1000 / Tape & Reel |
| MC14526BFG | SOEIAJ-16 (Pb-Free) | 50 Units / Rail |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

MC14526B

PACKAGE DIMENSIONS

PDIP-16
CASE 648-08
ISSUE T

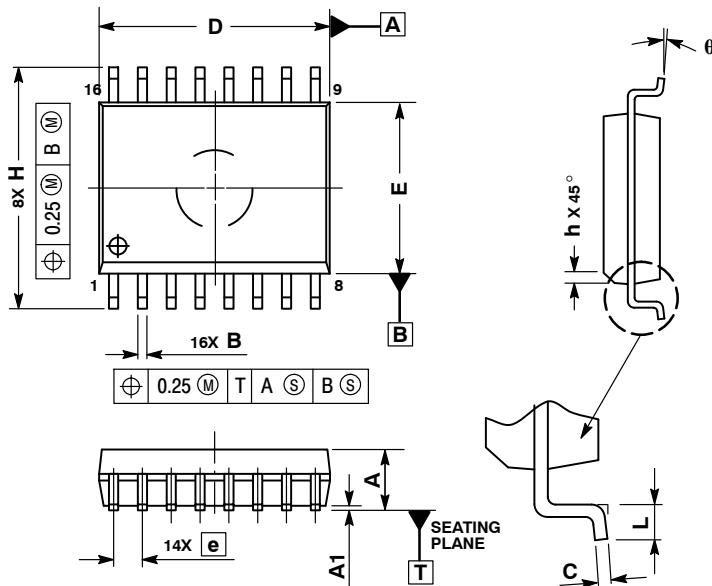


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.740 | 0.770 | 18.80 | 19.55 |
| B | 0.250 | 0.270 | 6.35 | 6.85 |
| C | 0.145 | 0.175 | 3.69 | 4.44 |
| D | 0.015 | 0.021 | 0.39 | 0.53 |
| F | 0.040 | 0.70 | 1.02 | 1.77 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.050 BSC | | 1.27 BSC | |
| J | 0.008 | 0.015 | 0.21 | 0.38 |
| K | 0.110 | 0.130 | 2.80 | 3.30 |
| L | 0.295 | 0.305 | 7.50 | 7.74 |
| M | 0° | 10° | 0° | 10° |
| S | 0.020 | 0.040 | 0.51 | 1.01 |

SOIC-16WB
CASE 751G-03
ISSUE C



NOTES:

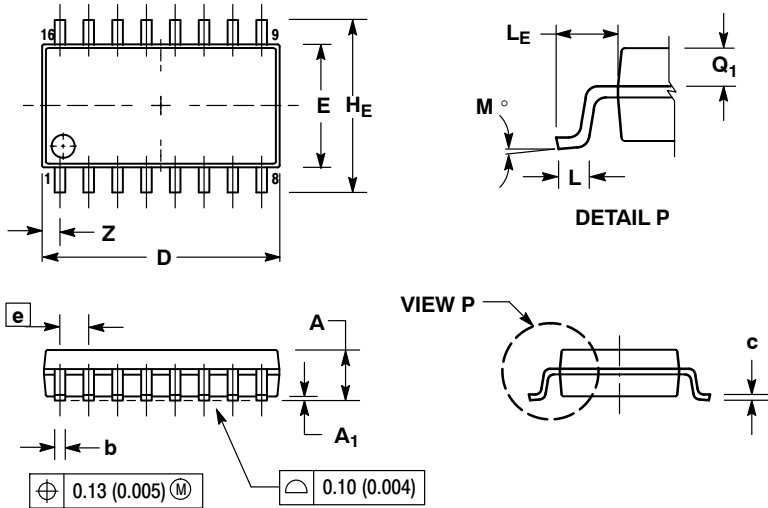
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | |
|-----|-------------|-------|
| | MIN | MAX |
| A | 2.35 | 2.65 |
| A1 | 0.10 | 0.25 |
| B | 0.35 | 0.49 |
| C | 0.23 | 0.32 |
| D | 10.15 | 10.45 |
| E | 7.40 | 7.60 |
| e | 1.27 BSC | |
| H | 10.05 | 10.55 |
| h | 0.25 | 0.75 |
| L | 0.50 | 0.90 |
| q | 0° | 7° |

MC14526B

PACKAGE DIMENSIONS

SOEIAJ-16
CASE 966-01
ISSUE A



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

| DIM | MILLIMETERS | | INCHES | |
|----------------|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | --- | 2.05 | --- | 0.081 |
| A ₁ | 0.05 | 0.20 | 0.002 | 0.008 |
| b | 0.35 | 0.50 | 0.014 | 0.020 |
| c | 0.10 | 0.20 | 0.007 | 0.011 |
| D | 9.90 | 10.50 | 0.390 | 0.413 |
| E | 5.10 | 5.45 | 0.201 | 0.215 |
| e | 1.27 BSC | | 0.050 BSC | |
| H _E | 7.40 | 8.20 | 0.291 | 0.323 |
| L | 0.50 | 0.85 | 0.020 | 0.033 |
| L _E | 1.10 | 1.50 | 0.043 | 0.059 |
| M | 0 ° | 10 ° | 0 ° | 10 ° |
| Q ₁ | 0.70 | 0.90 | 0.028 | 0.035 |
| Z | --- | 0.78 | --- | 0.031 |

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