

**IN74HCT163A**

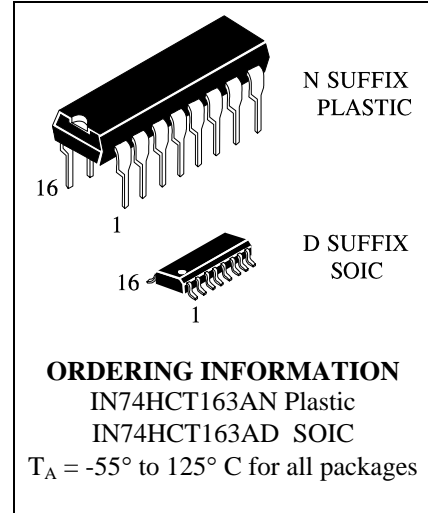
**Presettable Counters**  
**High-Performance Silicon-Gate CMOS**

The IN74HCT163A is identical in pinout to the LS/ALS163. The IN74HCT163 may be used as a level converter for interfacing TTL or NMOS outputs to High Speed CMOS inputs.

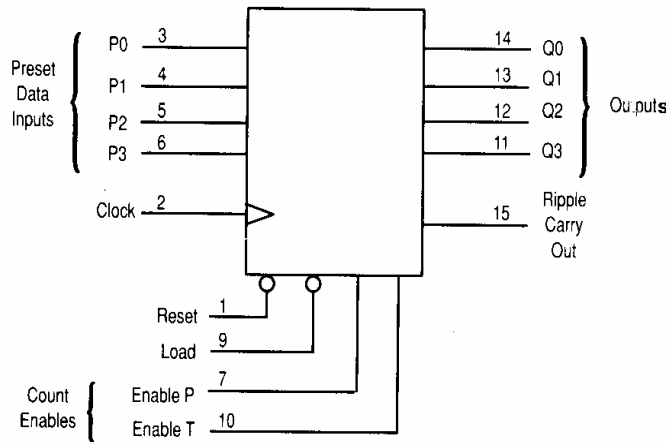
The IN74HCT163A is programmable 4-bit synchronous counter that feature parallel Load, synchronous Reset, a Carry Output for cascading and count-enable controls.

The IN74HCT163A is binary counter with synchronous Reset.

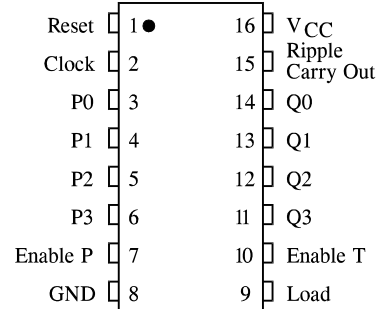
- TTL/NMOS Compatible Input Levels
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 4.5 to 5.5 V
- Low Input Current: 1.0  $\mu$ A



**LOGIC DIAGRAM**



**PIN ASSIGNMENT**



PIN 16 =  $V_{CC}$   
 PIN 8 = GND

**FUNCTION TABLE**

Inputs					Outputs				Function
Reset	Load	Enable P	Enable T	Clock	Q0	Q1	Q2	Q3	
L	X	X	X		L	L	L	L	Reset to "0"
H	L	X	X		P0	P1	P2	P3	Preset Data
H	H	X	L		No change				No count
H	H	L	X		No change				No count
H	H	H	H		Count up				Count
X	X	X	X		No change				No count

X=don't care  
 P0,P1,P2,P3 = logic level of Data inputs  
 Ripple Carry Out = Enable T • Q0 • Q1 • Q2 • Q3

**MAXIMUM RATINGS\***

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	DC Supply Voltage (Referenced to GND)	-0.5 to +7.0	V
V <sub>IN</sub>	DC Input Voltage (Referenced to GND)	-1.5 to V <sub>CC</sub> +1.5	V
V <sub>OUT</sub>	DC Output Voltage (Referenced to GND)	-0.5 to V <sub>CC</sub> +0.5	V
I <sub>IN</sub>	DC Input Current, per Pin	±20	mA
I <sub>OUT</sub>	DC Output Current, per Pin	±25	mA
I <sub>CC</sub>	DC Supply Current, V <sub>CC</sub> and GND Pins	±50	mA
P <sub>D</sub>	Power Dissipation in Still Air, Plastic DIP+ SOIC Package+	750 500	mW
T <sub>stg</sub>	Storage Temperature	-65 to +150	°C
T <sub>L</sub>	Lead Temperature, 1 mm from Case for 10 Seconds (Plastic DIP or SOIC Package)	260	°C

\*Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.

+Derating - Plastic DIP: - 10 mW/°C from 65° to 125°C  
SOIC Package: - 7 mW/°C from 65° to 125°C

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	DC Supply Voltage (Referenced to GND)	4.5	5.5	V
V <sub>IN</sub> , V <sub>OUT</sub>	DC Input Voltage, Output Voltage (Referenced to GND)	0	V <sub>CC</sub>	V
T <sub>A</sub>	Operating Temperature, All Package Types	-55	+125	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise and Fall Time (Figure 1)	0	500	ns

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<sub>IN</sub> and V<sub>OUT</sub> should be constrained to the range GND ≤ (V<sub>IN</sub> or V<sub>OUT</sub>) ≤ V<sub>CC</sub>.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V<sub>CC</sub>). Unused outputs must be left open.

**DC ELECTRICAL CHARACTERISTICS** (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	Guaranteed Limit			Unit
				25 °C to -55°C	≤85 °C	≤125 °C	
V <sub>IH</sub>	Minimum High-Level Input Voltage	V <sub>OUT</sub> =0.1 V or V <sub>CC</sub> -0.1 V  I <sub>OUT</sub>   ≤ 20 μA	4.5	2.0	2.0	2.0	V
			5.5	2.0	2.0	2.0	
V <sub>IL</sub>	Maximum Low - Level Input Voltage	V <sub>OUT</sub> =0.1 V or V <sub>CC</sub> -0.1 V  I <sub>OUT</sub>   ≤ 20 μA	4.5	0.8	0.8	0.8	V
			5.5	0.8	0.8	0.8	
V <sub>OH</sub>	Minimum High-Level Output Voltage	V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub>  I <sub>OUT</sub>   ≤ 20 μA	4.5	4.4	4.4	4.4	V
			5.5	5.4	5.4	5.4	
V <sub>OL</sub>	Maximum Low-Level Output Voltage	V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub>  I <sub>OUT</sub>   ≤ 6.0 mA	4.5	3.98	3.84	3.7	V
			5.5	0.1	0.1	0.1	
I <sub>IN</sub>	Maximum Input Leakage Current	V <sub>IN</sub> =V <sub>CC</sub> or GND	4.5	0.1	0.1	0.1	μA
			5.5	0.1	0.1	0.1	
I <sub>CC</sub>	Maximum Quiescent Supply Current (per Package)	V <sub>IN</sub> =V <sub>CC</sub> or GND I <sub>OUT</sub> =0μA	4.5	±0.1	±1.0	±1.0	μA
			5.5	4.0	40	160	
ΔI <sub>CC</sub>	Additional Quiescent Supply Current	V <sub>IN</sub> = 2.4 V, Any One Input V <sub>IN</sub> =V <sub>CC</sub> or GND, Other Inputs I <sub>OUT</sub> =0μA	5.5	≥-55°C	25°C to 125°C	mA	
				2.9	2.4		

**AC ELECTRICAL CHARACTERISTICS** ( $V_{CC}=5.0\text{ V} \pm 10\%$ ,  $C_L=50\text{pF}$ , Input  $t_r=t_f=6.0\text{ ns}$ )

Symbol	Parameter	Guaranteed Limit			Unit
		25 °C to -55°C	≤85°C	≤125°C	
$f_{max}$	Maximum Clock Frequency (Figures 1,6)	30	24	20	MHz
$t_{PLH}$	Maximum Propagation Delay, Clock to Q (Figures 1,6)	34	43	51	ns
$t_{PHL}$		41	51	62	ns
$t_{PLH}$	Maximum Propagation Delay, Enable T to Ripple Carry Out (Figures 2,6)	32	40	48	ns
$t_{PHL}$		39	49	59	ns
$t_{PLH}$	Maximum Propagation Delay, Clock to Ripple Carry Out (Figures 1,6)	35	44	53	ns
$t_{PHL}$		43	54	65	ns
$t_{TLH}, t_{THL}$	Maximum Output Transition Time, Any Output, (Figures 1 and 6)	15	19	22	ns
$C_{IN}$	Maximum Input Capacitance	10	10	10	pF

$C_{PD}$	Power Dissipation Capacitance (Per Gate)	Typical @25°C, $V_{CC}=5.0\text{ V}$			pF
	Used to determine the no-load dynamic power consumption: $P_D=C_{PD}V_{CC}^2f+I_{CC}V_{CC}+\Delta I_{CC}V_{CC}$	60			

**TIMING REQUIREMENTS** ( $V_{CC}=5.0\text{ V} \pm 10\%$ ,  $C_L=50\text{pF}$ , Input  $t_r=t_f=6.0\text{ ns}$ )

Symbol	Parameter	Guaranteed Limit			Unit
		25 °C to -55°C	≤85°C	≤125°C	
$t_{su}$	Minimum Setup Time, Preset Data Inputs to Clock (Figure 4)	30	38	45	ns
$t_{su}$	Minimum Setup Time, Load to Clock (Figure 4)	27	34	41	ns
$t_{su}$	Minimum Setup Time, Reset to Clock (Figure 3)	32	40	48	ns
$t_{su}$	Minimum Setup Time, Enable T or Enable P to Clock (Figure 5)	40	50	60	ns
$t_h$	Minimum Hold Time, Clock to Preset Data Inputs (Figure 4)	10	13	15	ns
$t_h$	Minimum Hold Time, Clock to Load (Figure 4)	3	3	3	ns
$t_h$	Minimum Hold Time, Clock to Reset (Figure 3)	3	3	3	ns
$t_h$	Minimum Hold Time, Clock to Enable T or Enable P (Figure 5)	3	3	3	ns
$t_{rec}$	Minimum Recovery Time, Load Inactive to Clock (Figure 4)	25	31	38	ns
$t_w$	Minimum Pulse Width, Clock (Figure 1)	16	20	24	ns
$t_w$	Minimum Pulse Width, Reset (Figure 4)	16	20	24	ns
$t_r, t_f$	Maximum Input Rise and Fall Times (Figure 1)	500	500	500	ns

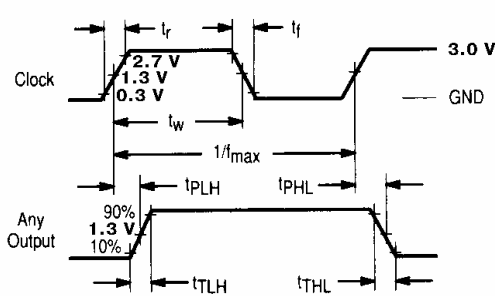


Figure 1. Switching Waveforms

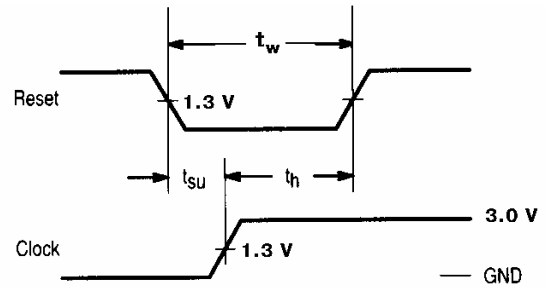


Figure 2. Switching Waveforms

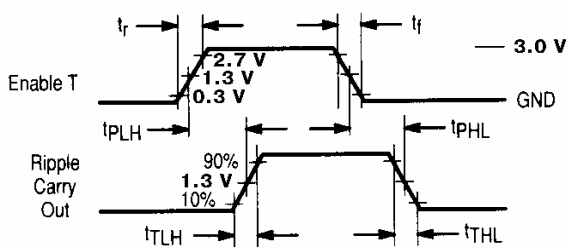


Figure 3. Switching Waveforms

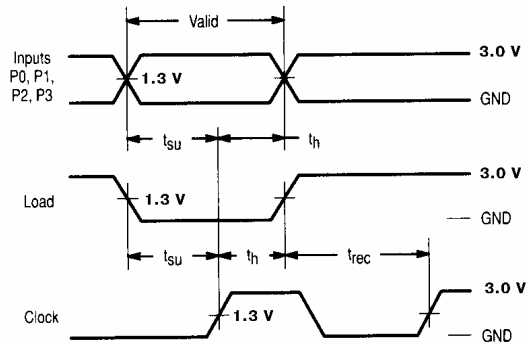


Figure 4. Switching Waveforms

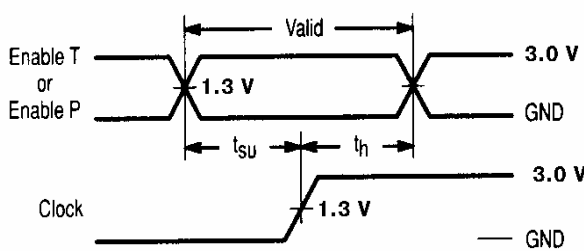
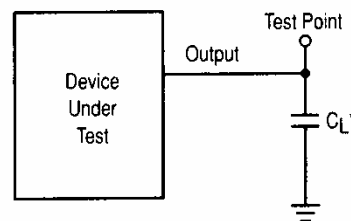
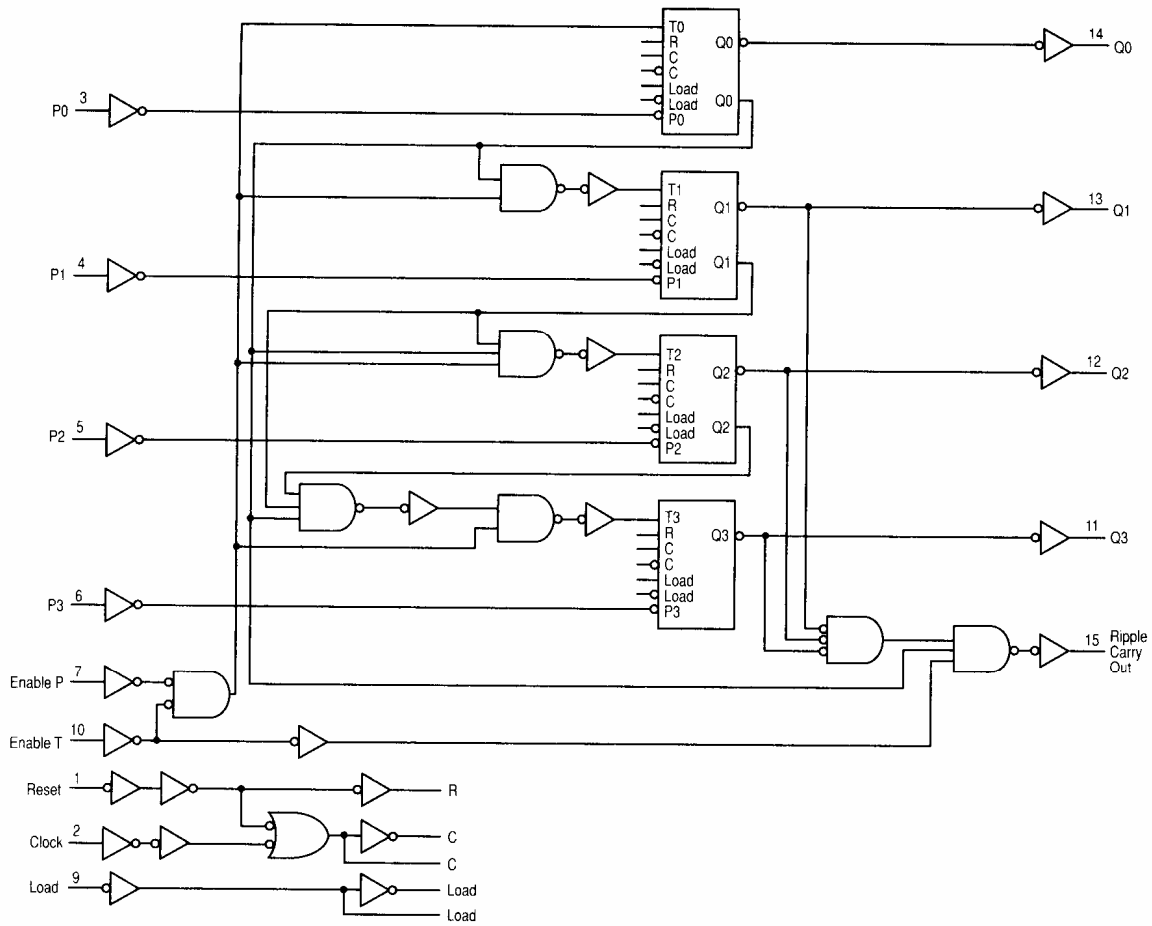


Figure 5. Switching Waveforms



\*Includes all probe and jig capacitance.

Figure 6. Test Circuit

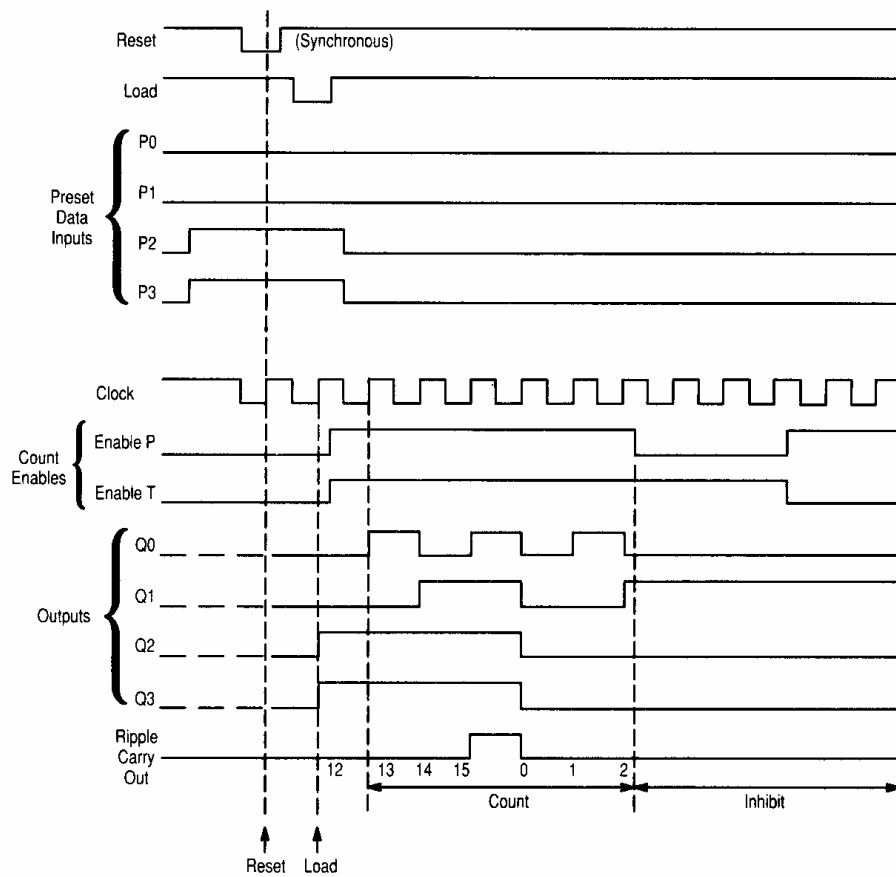


V<sub>CC</sub>=Pin 16  
GND=Pin 8

The flip-flops shown in the circuit diagrams are Toggle-Enable flip-flops. A Toggle-Enable flip-flop is a combination of a D flip-flop and a T flip-flop. When loading data from Preset inputs P0, P1, P2, and P3, the Load signal is used to disable the Toggle input (T<sub>n</sub>) of the flip-flop. The logic level at the P<sub>n</sub> input is then clocked to the Q output of the flip-flop on the next rising edge of the clock.

A logic zero on the Reset device input forces the internal clock (C) high and resets the Q output of the flip-flop low.

Figure 7.Expanded logic diagram

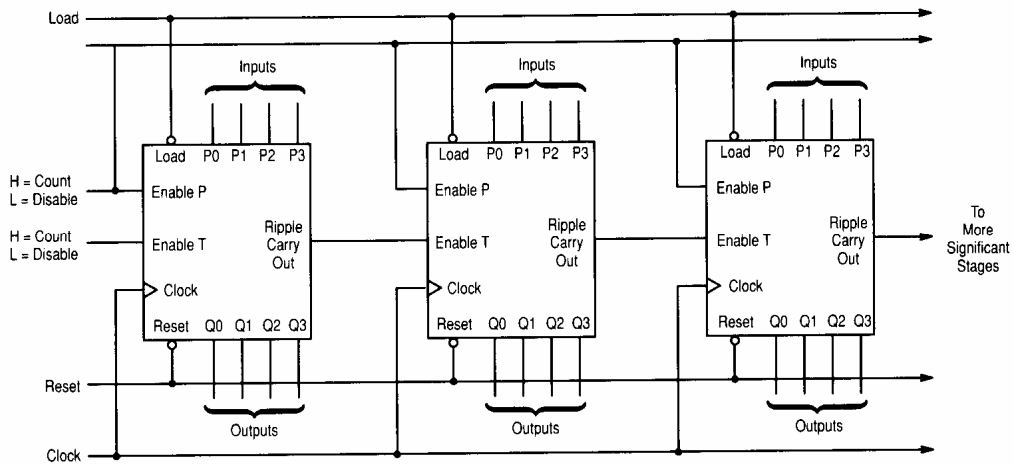


Sequence illustrated in waveforms:

1. Reset outputs to zero.
2. Preset to binary twelve.
3. Count to thirteen, fourteen, fifteen, zero, one, and two.
4. Inhibit.

**Figure 8. Timing Diagram**

TYPICAL APPLICATIONS CASCADING



Note: When used in these cascaded configurations the clock  $f_{max}$  guaranteed limits may not apply. Actual performance will depend on number of stages. This limitation is due to set up times between Enable (Port) and clock.

Figure 9. N-Bit Synchronous Counters

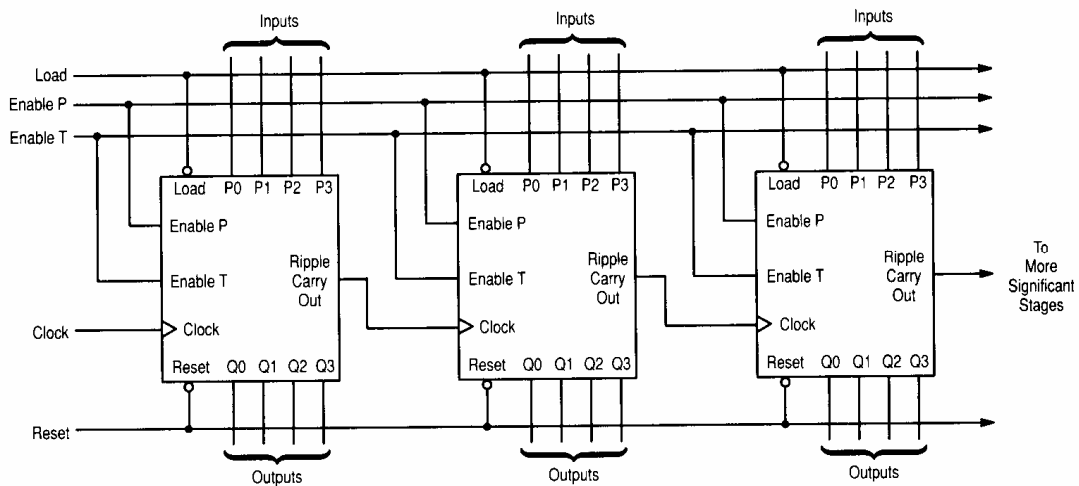
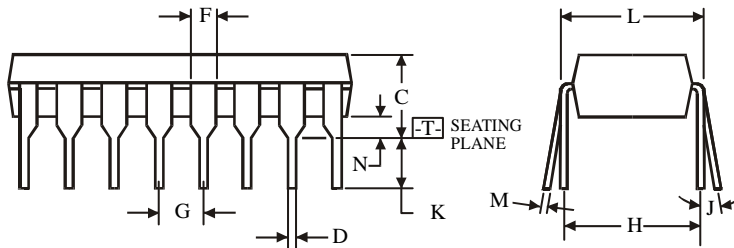
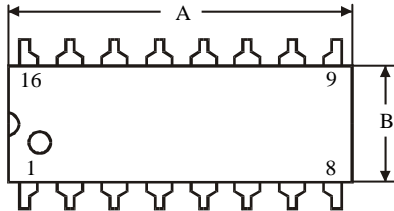
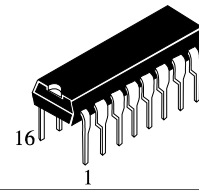


Figure 10. Nibble Ripple Counter



**N SUFFIX PLASTIC DIP  
(MS - 001BB)**



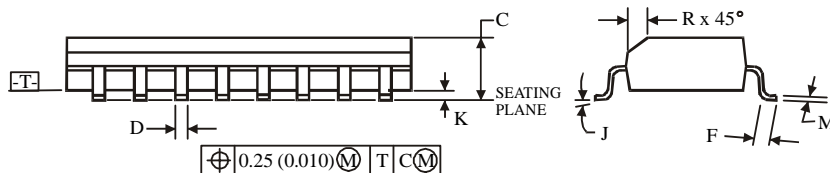
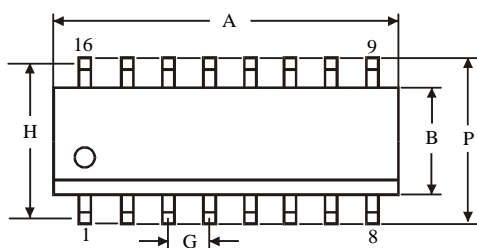
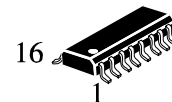
$\oplus 0.25 (0.010) \text{ (M) T}$

**NOTES:**

- Dimensions "A", "B" do not include mold flash or protrusions.  
Maximum mold flash or protrusions 0.25 mm (0.010) per side.

Symbol	Dimension, mm	
	MIN	MAX
A	18.67	19.69
B	6.1	7.11
C		5.33
D	0.36	0.56
F	1.14	1.78
G	2.54	
H	7.62	
J	0°	10°
K	2.92	3.81
L	7.62	8.26
M	0.2	0.36
N	0.38	

**D SUFFIX SOIC  
(MS - 012AC)**



$\oplus 0.25 (0.010) \text{ (M) T C (M)}$

**NOTES:**

- Dimensions A and B do not include mold flash or protrusion.
- Maximum mold flash or protrusion 0.15 mm (0.006) per side for A; for B - 0.25 mm (0.010) per side.

Symbol	Dimension, mm	
	MIN	MAX
A	9.8	10
B	3.8	4
C	1.35	1.75
D	0.33	0.51
F	0.4	1.27
G	1.27	
H	5.72	
J	0°	8°
K	0.1	0.25
M	0.19	0.25
P	5.8	6.2
R	0.25	0.5