MC74HC161A, MC74HC163A

Presettable Counters

High−Performance Silicon−Gate CMOS

The MC74HC161A and HC163A are identical in pinout to the LS161 and LS163. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

The HC161A and HC163A are programmable 4−bit binary counters with asynchronous and synchronous reset, respectively.

Features

- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2.0 to 6.0 V
- Low Input Current: 1.0 μA
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the Requirements Defined by JEDEC Standard No. 7A
- Chip Complexity: 192 FETs or 48 Equivalent Gates
- Pb−Free Packages are Available*

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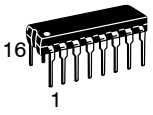
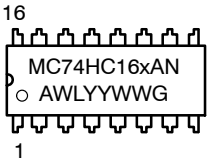
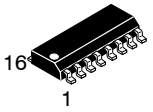
MARKING DIAGRAMS

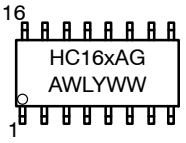


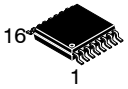
PDIP−16
N SUFFIX
CASE 648



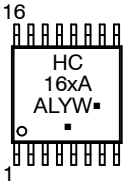


SOIC−16
D SUFFIX
CASE 751B





TSSOP−16
DT SUFFIX
CASE 948F



x	= 1 or 3
A	= Assembly Location
WL, L	= Wafer Lot
YY, Y	= Year
WW, W	= Work Week
G or ▪	= Pb−Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 13 of this data sheet.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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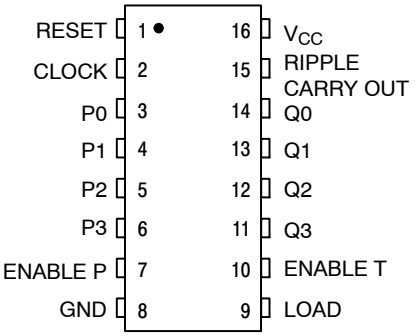


Figure 1. Pin Assignment

FUNCTION TABLE

Inputs					Output
Clock	Reset*	Load	Enable P	Enable T	Q
↗	L	X	X	X	Reset
↗	H	L	X	X	Load Preset Data
↗	H	H	H	H	Count
↗	H	H	L	X	No Count
↗	H	H	X	L	No Count

*HC163A only. HC161A is an Asynchronous Reset Device
H = high level, L = low level, X = don't care

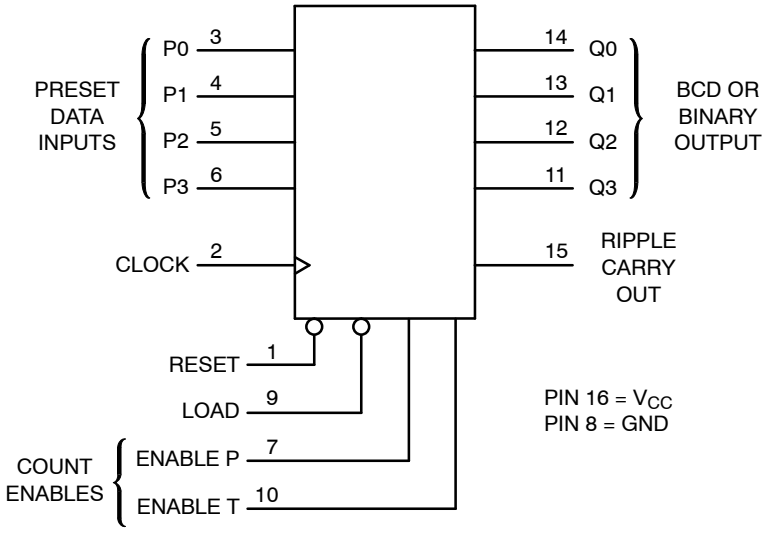


Figure 2. Logic Diagram

DEVICE/MODE TABLE

Device	Count Mode	Reset Mode
HC161A	Binary	Asynchronous
HC163A	Binary	Synchronous

MAXIMUM RATINGS

Symbol	Parameter		Value	Unit
V_{CC}	DC Supply Voltage		−0.5 to +7.0	V
V_I	DC Input Voltage		−0.5 to V_{CC} +0.5	V
V_O	DC Output Voltage	(Note 1)	−0.5 ≤ V_O ≤ V_{CC} +0.5	V
I_{IK}	DC Input Diode Current		±20	mA
I_{OK}	DC Output Diode Current		±25	mA
I_O	DC Output Sink Current		±25	mA
I_{CC}	DC Supply Current per Supply Pin		±50	mA
I_{GND}	DC Ground Current per Ground Pin		±50	mA
T_{STG}	Storage Temperature Range		−65 to +150	°C
T_L	Lead Temperature, 1 mm from Case for 10 Seconds		260	°C
T_J	Junction Temperature Under Bias		+150	°C
θ_{JA}	Thermal Resistance	PDIP SOIC TSSOP	78 112 148	°C/W
P_D	Power Dissipation in Still Air at 85°C	PDIP SOIC TSSOP	750 500 450	mW
MSL	Moisture Sensitivity		Level 1	
F_R	Flammability Rating	Oxygen Index: 30% − 35%	UL 94 V−0 @ 0.125 in	
V_{ESD}	ESD Withstand Voltage	Human Body Model (Note 2) Machine Model (Note 3)	>2000 >200	V
$I_{LATCHUP}$	Latchup Performance	Above V_{CC} and Below GND at 85°C (Note 4)	±300	mA

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. I_O absolute maximum rating must be observed.
2. Tested to EIA/JESD22−A114−A.
3. Tested to EIA/JESD22−A115−A.
4. Tested to EIA/JESD78.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter		Min	Max	Unit
V_{CC}	DC Supply Voltage	(Referenced to GND)	2.0	6.0	V
V_{in}, V_{out}	DC Input Voltage, Output Voltage	(Referenced to GND)	0	V_{CC}	V
T_A	Operating Temperature, All Package Types		−55	+125	°C
t_r, t_f	Input Rise and Fall Time (Figure 4)	V_{CC} = 2.0 V V_{CC} = 3.0 V V_{CC} = 4.5 V V_{CC} = 6.0 V	0 0 0 0	1000 600 500 400	ns

5. Unused inputs may not be left open. All inputs must be tied to a high− or low−logic input voltage level.

DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V_{CC} V	Guaranteed Limit			Unit
				–55 to 25°C	≤ 85°C	≤ 125°C	
V_{IH}	Minimum High–Level Input Voltage	V_{out} = 0.1 V or V_{CC} – 0.1 V $\|I_{out}\| \leq 20$ μA	2.0 3.0 4.5 6.0	1.5 2.1 3.15 4.2	1.5 2.1 3.15 4.2	1.5 2.1 3.15 4.2	V
V_{IL}	Maximum Low–Level Input Voltage	V_{out} = 0.1 V or V_{CC} – 0.1 V $\|I_{out}\| \leq 20$ μA	2.0 3.0 4.5 6.0	0.5 0.9 1.35 1.8	0.5 0.9 1.35 1.8	0.5 0.9 1.35 1.8	V
V_{OH}	Minimum High–Level Output Voltage	V_{in} = V_{IH} or V_{IL} $\|I_{out}\| \leq 20$ μA	2.0 4.5 6.0	1.9 4.4 5.9	1.9 4.4 5.9	1.9 4.4 5.9	V
		V_{in} = V_{IH} or V_{IL} $\|I_{out}\| \leq 3.6$ mA $\|I_{out}\| \leq 4.0$ mA $\|I_{out}\| \leq 5.2$ mA	3.0 4.5 6.0	2.48 3.98 5.48	2.34 3.84 5.34	2.2 3.7 5.2	
V_{OL}	Maximum Low–Level Output Voltage	V_{in} = V_{IH} or V_{IL} $\|I_{out}\| \leq 20$ μA	2.0 4.5 6.0	0.1 0.1 0.1	0.1 0.1 0.1	0.1 0.1 0.1	V
		V_{in} = V_{IH} or V_{IL} $\|I_{out}\| \leq 3.6$ mA $\|I_{out}\| \leq 4.0$ mA $\|I_{out}\| \leq 5.2$ mA	3.0 4.5 6.0	0.26 0.26 0.26	0.33 0.33 0.33	0.4 0.4 0.4	
I_{in}	Maximum Input Leakage Current	V_{in} = V_{CC} or GND	6.0	± 0.1	± 1.0	± 1.0	μA
I_{CC}	Maximum Quiescent Supply Current	V_{in} = V_{CC} or GND I_{out} = 0 μA	6.0	4.0	40	160	μA

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input $t_r = t_f$ = 6.0 ns)

Symbol	Parameter	Figure	V_{CC} V	Guaranteed Limit			Unit
				– 55 to 25°C	≤ 85°C	≤ 125°C	
f_{max}	Maximum Clock Frequency (50% Duty Cycle) (Note 6)	4, 10	2.0 3.0 4.5 6.0	6 15 30 35	5 12 24 28	4 10 20 24	MHz
t_{PLH}	Maximum Propagation Delay, Clock to Q	4, 10	2.0 3.0 4.5 6.0	120 75 20 16	160 120 23 20	200 150 28 22	ns
t_{PHL}		4, 10	2.0 3.0 4.5 6.0	145 100 22 18	185 135 25 20	220 150 30 23	ns
t_{PHL}	Maximum Propagation Delay, Reset to Q (HC161A Only)	5, 10	2.0 3.0 4.5 6.0	145 100 20 17	185 135 22 19	220 150 25 21	ns
t_{PLH}	Maximum Propagation Delay, Enable T to Ripple Carry Out	6, 10	2.0 3.0 4.5 6.0	110 60 16 14	150 115 18 15	190 140 20 17	ns
t_{PHL}		6, 10	2.0 3.0 4.5 6.0	135 100 18 15	175 130 20 16	210 160 22 20	ns
t_{PLH}	Maximum Propagation Delay, Clock to Ripple Carry Out	4, 10	2.0 3.0 4.5 6.0	120 75 22 18	160 135 27 22	200 150 30 25	ns
t_{PHL}		4, 10	2.0 3.0 4.5 6.0	145 100 22 20	185 135 28 24	220 150 35 28	ns
t_{PHL}	Maximum Propagation Delay, Reset to Ripple Carry Out (HC161A Only)	5, 10	2.0 3.0 4.5 6.0	155 120 22 18	190 140 26 22	230 155 30 25	ns
t_{TLH}, t_{THL}	Maximum Output Transition Time, Any Output	5, 10	2.0 3.0 4.5 6.0	75 30 15 13	95 40 19 16	110 55 22 19	ns
C_{in}	Maximum Input Capacitance	4, 10	–	10	10	10	pF

6. Applies to noncascaded/nonsynchronous clocked configurations only with synchronously cascaded counters. (1) Clock to Ripple Carry Out propagation delays. (2) Enable T or Enable P to Clock setup times and (3) Clock to Enable T or Enable P hold times determine f_{max}. However, if Ripple Carry out of each stage is tied to the Clock of the next stage (nonsynchronously clocked) the f_{max} in the table above is applicable. See Applications information in this data sheet.

		Typical @ 25°C, V_{CC} = 5.0 V	
C_{PD}	Power Dissipation Capacitance (Per Gate) (Note 7)	45	pF

7. Used to determine the no−load dynamic power consumption: $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$.

TIMING REQUIREMENTS (C_L = 50 pF, Input $t_r = t_f$ = 6.0 ns)

Symbol	Parameter	Figure	V_{CC} V	Guaranteed Limit			Unit
				– 55 to 25°C	≤ 85°C	≤ 125°C	
t_{su}	Minimum Setup Time, Preset Data Inputs to Clock	8	2.0 3.0 4.5 6.0	40 20 15 12	60 30 20 18	80 40 30 20	ns
t_{su}	Minimum Setup Time, Load to Clock	8	2.0 3.0 4.5 6.0	60 25 15 12	75 30 20 18	90 40 30 20	ns
t_{su}	Minimum Setup Time, Reset to Clock (HC163A Only)	7	2.0 3.0 4.5 6.0	60 25 20 17	75 30 25 23	90 40 35 25	ns
t_{su}	Minimum Setup Time, Enable T or Enable P to Clock	9	2.0 3.0 4.5 6.0	80 35 20 17	95 40 25 23	110 50 35 25	ns
t_h	Minimum Hold Time, Clock to Load or Preset Data Inputs	8	2.0 3.0 4.5 6.0	3 3 3 3	3 3 3 3	3 3 3 3	ns
t_h	Minimum Hold Time, Clock to Reset (HC163A Only)	7	2.0 3.0 4.5 6.0	3 3 3 3	3 3 3 3	3 3 3 3	ns
t_h	Minimum Hold Time, Clock to Enable T or Enable P	9	2.0 3.0 4.5 6.0	3 3 3 3	3 3 3 3	3 3 3 3	ns
t_{rec}	Minimum Recovery Time, Reset Inactive to Clock (HC161A Only)	5	2.0 3.0 4.5 6.0	80 35 15 12	95 40 20 17	110 50 26 23	ns
t_{rec}	Minimum Recovery Time, Load Inactive to Clock	8	2.0 3.0 4.5 6.0	80 35 15 12	95 40 20 17	110 50 26 23	ns
t_w	Minimum Pulse Width, Clock	4	2.0 3.0 4.5 6.0	60 25 12 10	75 30 15 13	90 40 18 15	ns
t_w	Minimum Pulse Width, Reset (HC161A Only)	5	2.0 3.0 4.5 6.0	60 25 12 10	75 30 15 13	90 40 18 15	ns
t_r, t_f	Maximum Input Rise and Fall Times		2.0 3.0 4.5 6.0	1000 800 500 400	1000 800 500 400	1000 800 500 400	ns

FUNCTION DESCRIPTION

The HC161A/163A are programmable 4−bit synchronous counters that feature parallel Load, synchronous or asynchronous Reset, a Carry Output for cascading, and count−enable controls.

The HC161A and HC163A are binary counters with asynchronous Reset and synchronous Reset, respectively.

INPUTS

Clock (Pin 2)

The internal flip−flops toggle and the output count advances with the rising edge of the Clock input. In addition, control functions, such as resetting and loading, occur with the rising edge of the Clock input.

Preset Data Inputs P0, P1, P2, P3 (Pins 3, 4, 5, 6)

These are the data inputs for programmable counting. Data on these pins may be synchronously loaded into the internal flip−flops and appear at the counter outputs. P0 (Pin 3) is the least−significant bit and P3 (Pin 6) is the most−significant bit.

OUTPUTS

Q0, Q1, Q2, Q3 (Pins 14, 13, 12, 11)

These are the counter outputs. Q0 (Pin 14) is the least−significant bit and Q3 (Pin 11) is the most−significant bit.

Ripple Carry Out (Pin 15)

When the counter is in its maximum state, 1111, this output goes high, providing an external look−ahead carry pulse that may be used to enable successive cascaded counters. Ripple Carry Out remains high only during the maximum count state. The logic equation for this output is:

$$\text{Ripple Carry Out} = \text{Enable T} \bullet Q0 \bullet Q1 \bullet Q2 \bullet Q3$$

OUTPUT STATE DIAGRAMS

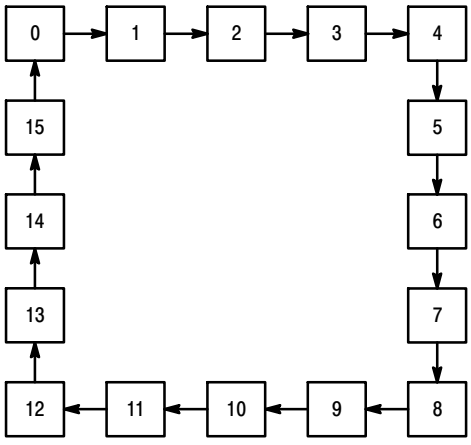


Figure 3. Binary Counters

CONTROL FUNCTIONS

Resetting

A low level on the Reset pin (Pin 1) resets the internal flip−flops and sets the outputs (Q0 through Q3) to a low level. The HC161A resets asynchronously, and the HC163A resets with the rising edge of the Clock input (synchronous reset).

Loading

With the rising edge of the Clock, a low level on Load (Pin 9) loads the data from the Preset Data input pins (P0, P1, P2, P3) into the internal flip−flops and onto the output pins, Q0 through Q3. The count function is disabled as long as Load is low.

Count Enable/Disable

These devices have two count−enable control pins: Enable P (Pin 7) and Enable T (Pin 10). The devices count when these two pins and the Load pin are high. The logic equation is:

$$\text{Count Enable} = \text{Enable P} \bullet \text{Enable T} \bullet \text{Load}$$

The count is either enabled or disabled by the control inputs according to Table 1. In general, Enable P is a count−enable control: Enable T is both a count−enable and a Ripple−Carry Output control.

Table 1. Count Enable/Disable

Control Inputs			Result at Outputs	
Load	**Enable P**	**Enable T**	**Q0 − Q3**	**Ripple Carry Out**
H	H	H	Count	High when Q0−Q3 are maximum*
L	H	H	No Count	
X	L	H	No Count	High when Q0−Q3 are maximum*
X	X	L	No Count	L

*Q0 through Q3 are maximum when Q3, Q2, Q1, Q0 = 1111.

SWITCHING WAVEFORMS

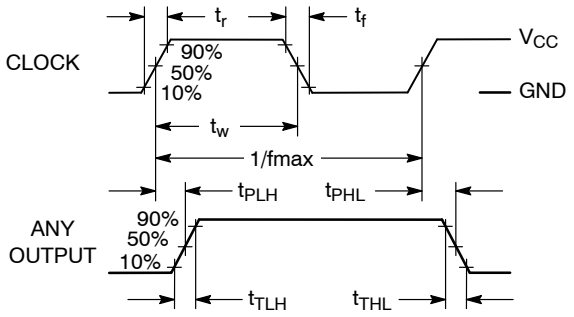


Figure 4.

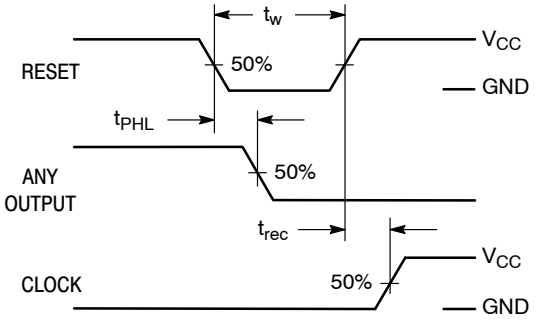


Figure 5.

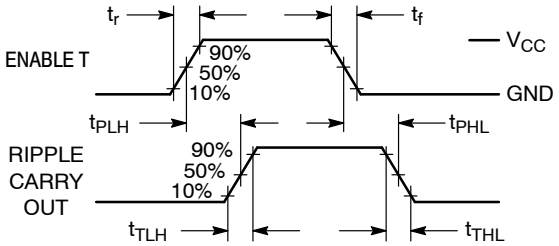


Figure 6.

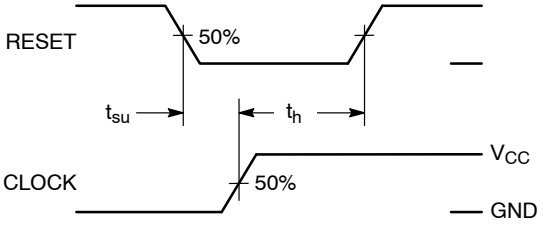


Figure 7. HC163A Only

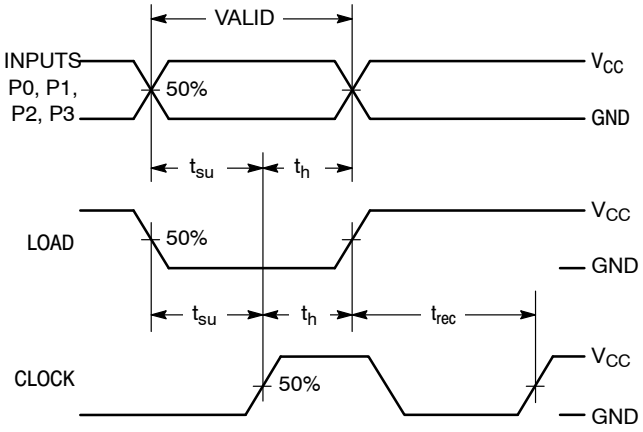


Figure 8.

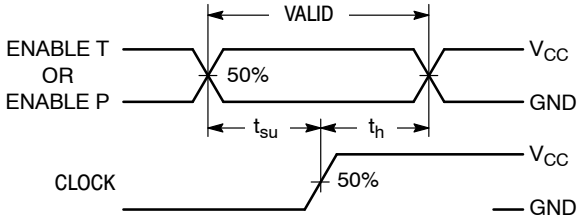
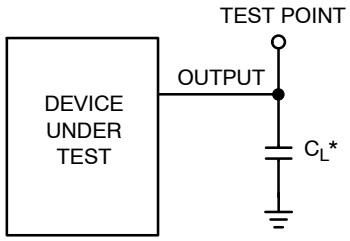


Figure 9.

TEST CIRCUIT



*Includes all probe and jig capacitance

Figure 10.

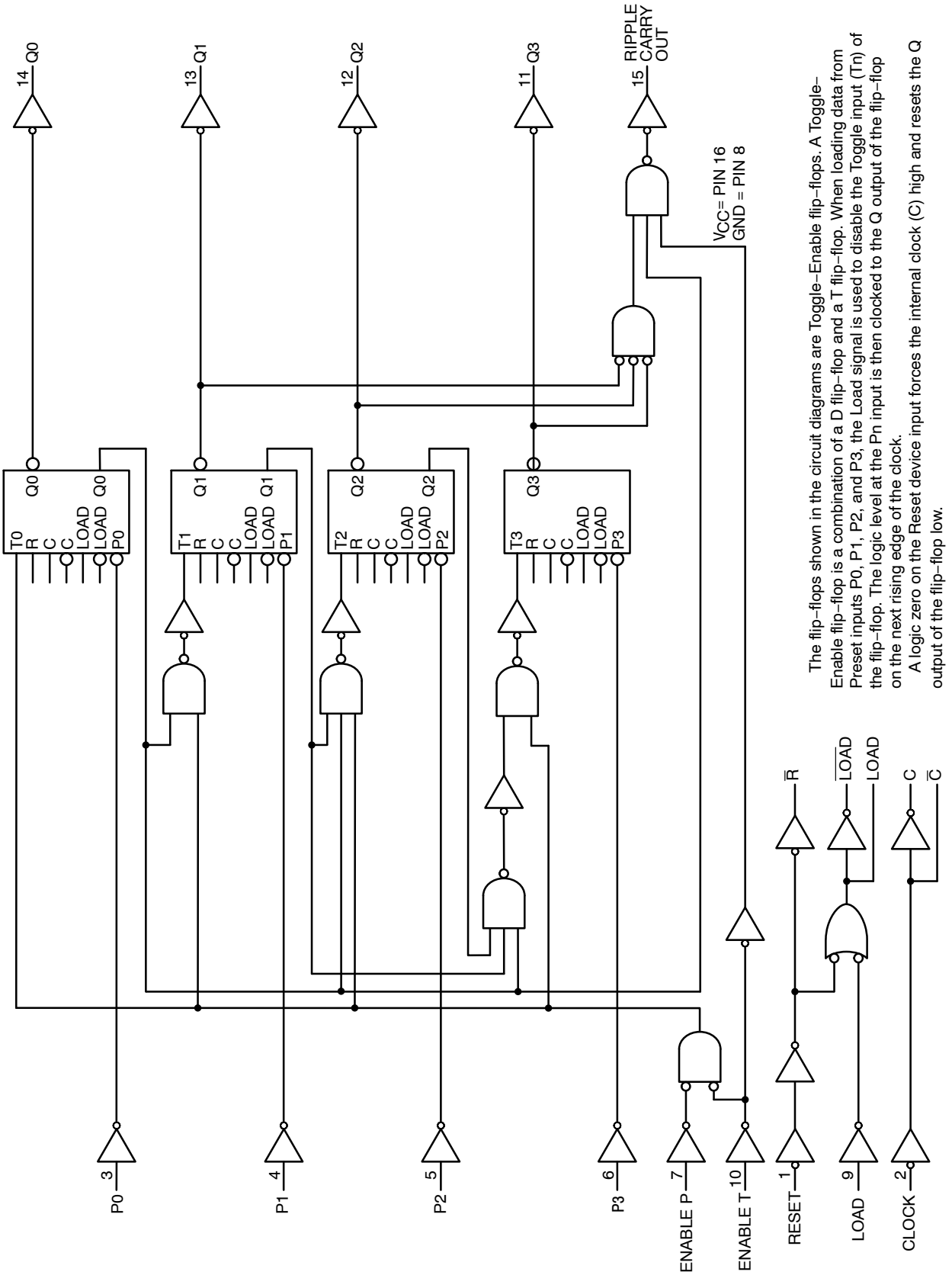


Figure 11. 4−Bit Binary Counter with Asynchronous Reset (MC74HC161A)

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.

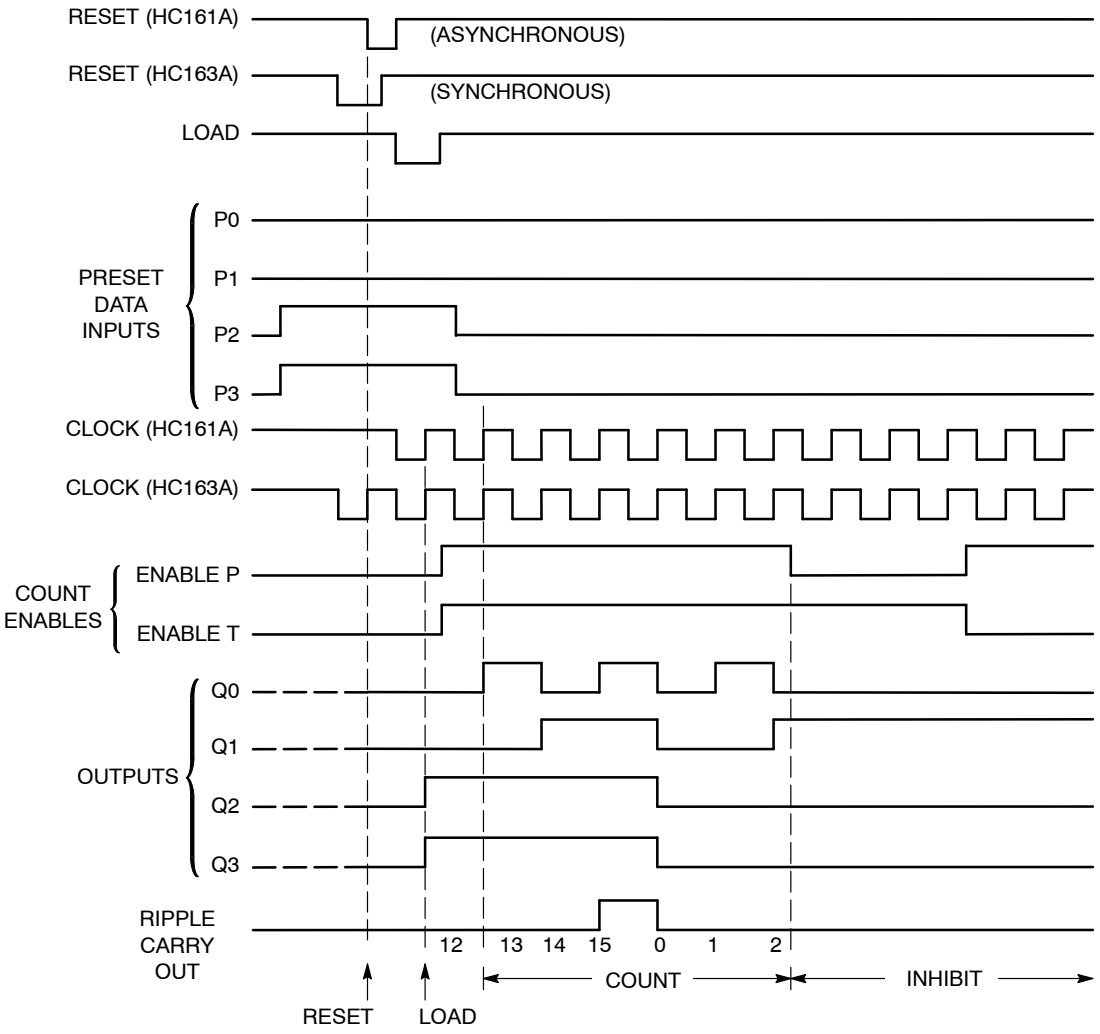


Figure 12. Timing Diagram

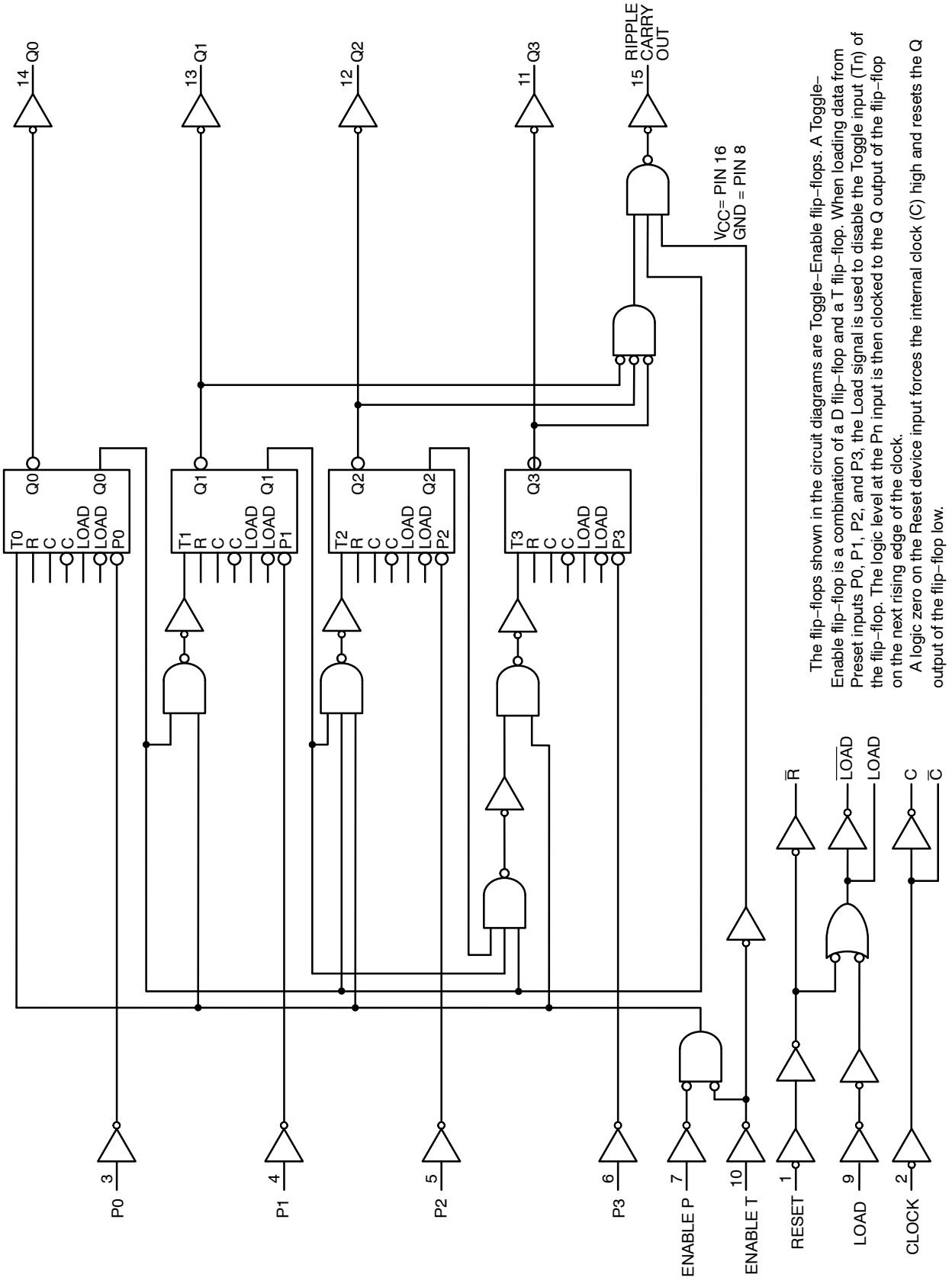
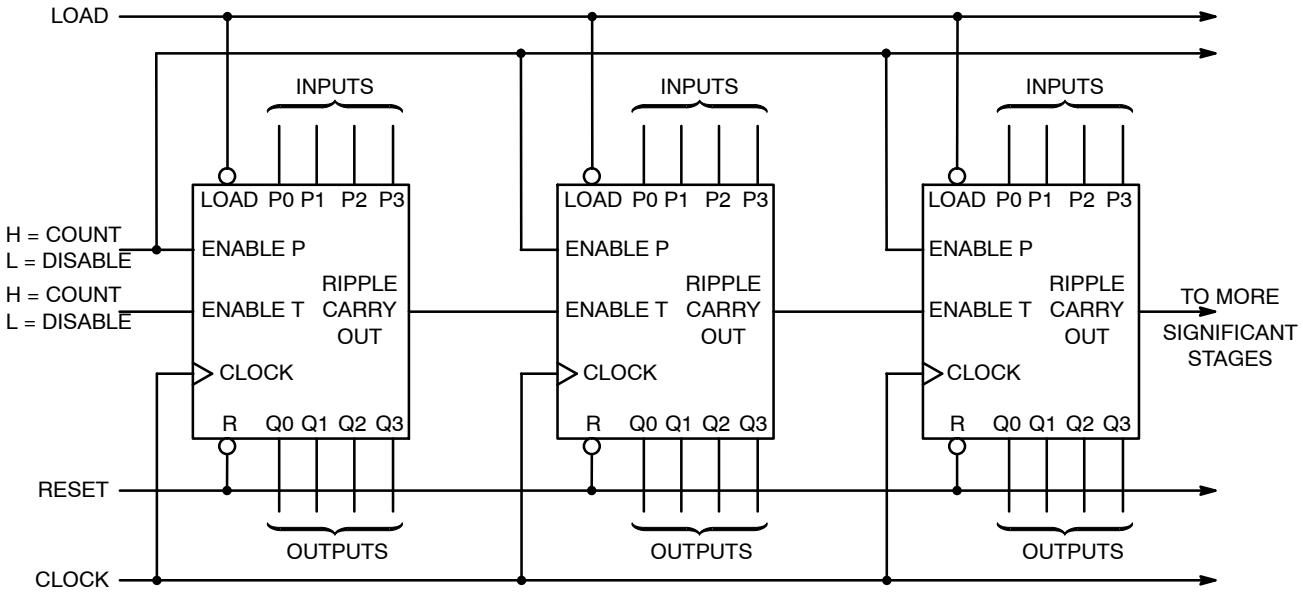


Figure 13. 4−Bit Binary Counter with Synchronous Reset (MC74HC163A)

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 14. N−Bit Synchronous Counters

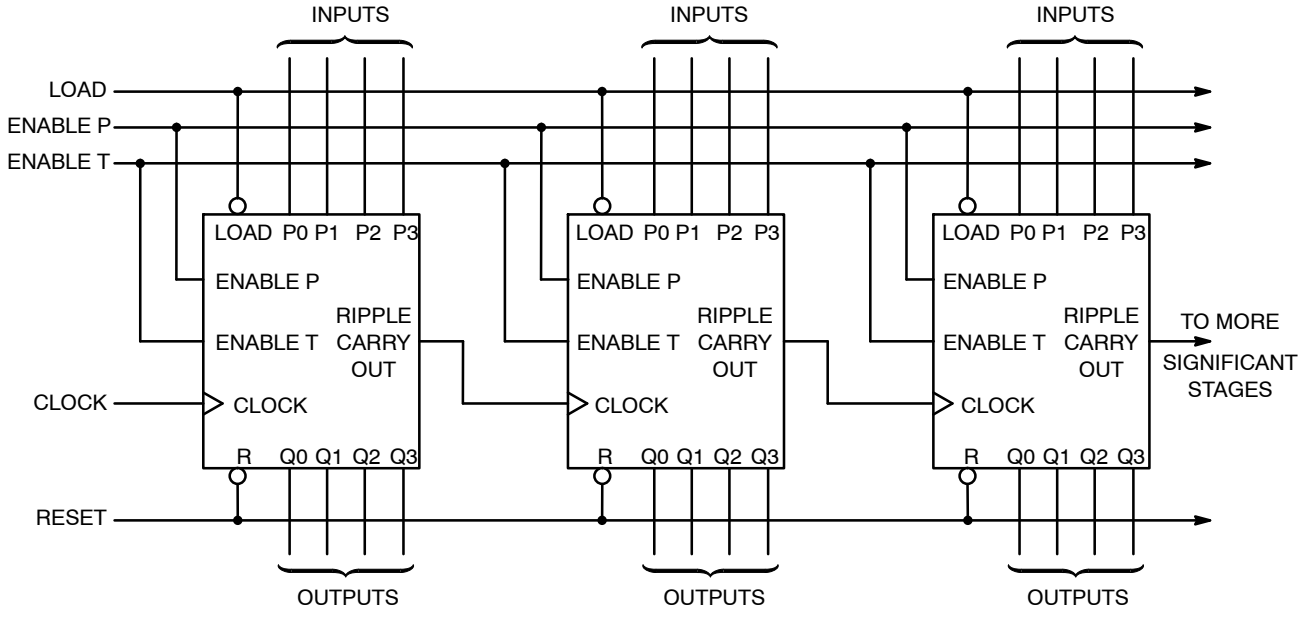


Figure 15. Nibble Ripple Counter

TYPICAL APPLICATIONS VARYING THE MODULUS

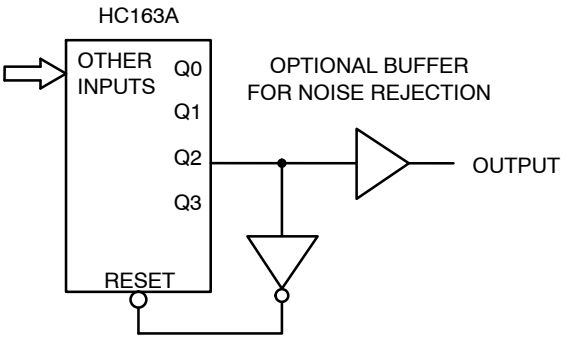


Figure 16. Modulo−5 Counter

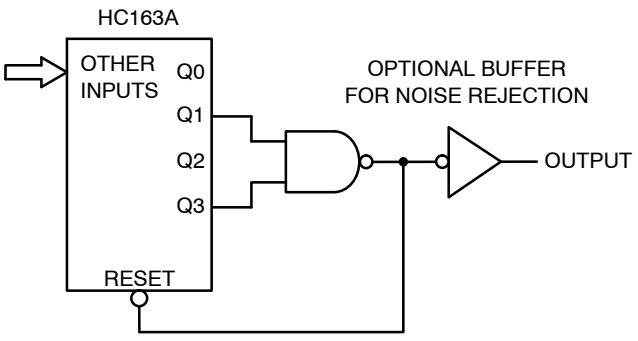


Figure 17. Modulo−11 Counter

The HC163A facilitates designing counters of any modulus with minimal external logic. The output is glitch−free due to the synchronous Reset.

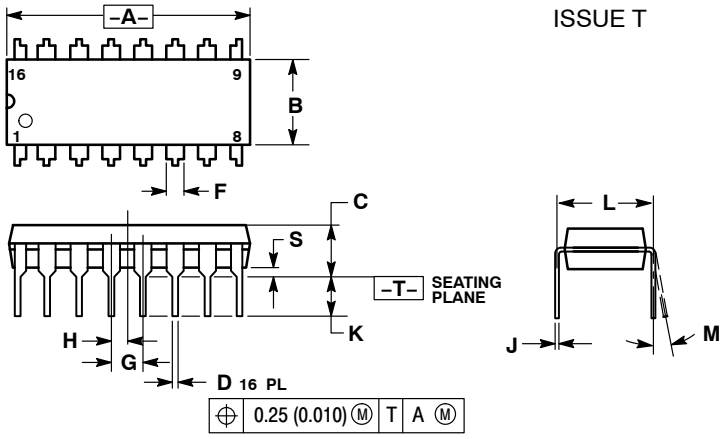
ORDERING INFORMATION

Device	Package	Shipping†
MC74HC161ANG	PDIP−16 (Pb−Free)	500 Units / Box
MC74HC161ADG	SOIC−16 (Pb−Free)	48 Units / Rail
MC74HC161ADR2G	SOIC−16 (Pb−Free)	2500 Units / Tape & Reel
MC74HC161ADTR2G	TSSOP−16*	2500 Units / Tape & Reel
MC74HC163ANG	PDIP−16 (Pb−Free)	500 Units / Box
MC74HC163ADG	SOIC−16 (Pb−Free)	48 Units / Rail
MC74HC163ADR2G	SOIC−16 (Pb−Free)	2500 Units / Tape & Reel
MC74HC163ADTR2G	TSSOP−16*	2500 Units / Tape & Reel

†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.
*This package is inherently Pb−Free.

PACKAGE DIMENSIONS

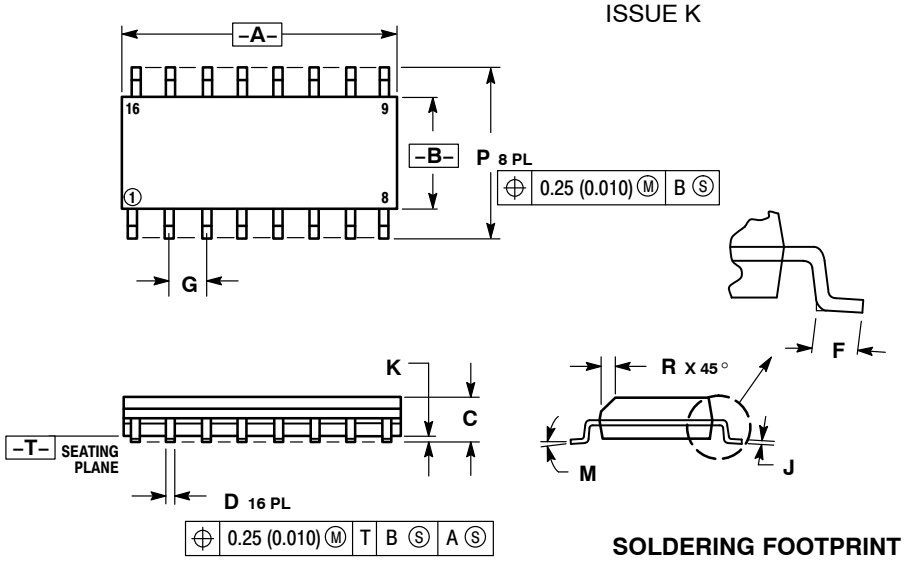
PDIP−16
N SUFFIX
CASE 648−08
ISSUE T



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.

	INCHES		MILLIMETERS	
DIM	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

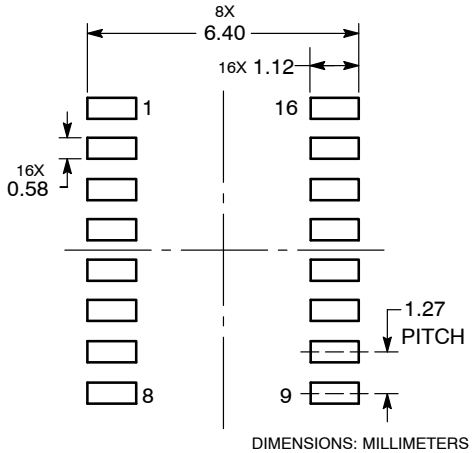
SOIC−16
D SUFFIX
CASE 751B−05
ISSUE K



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0 °	7 °	0 °	7 °
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

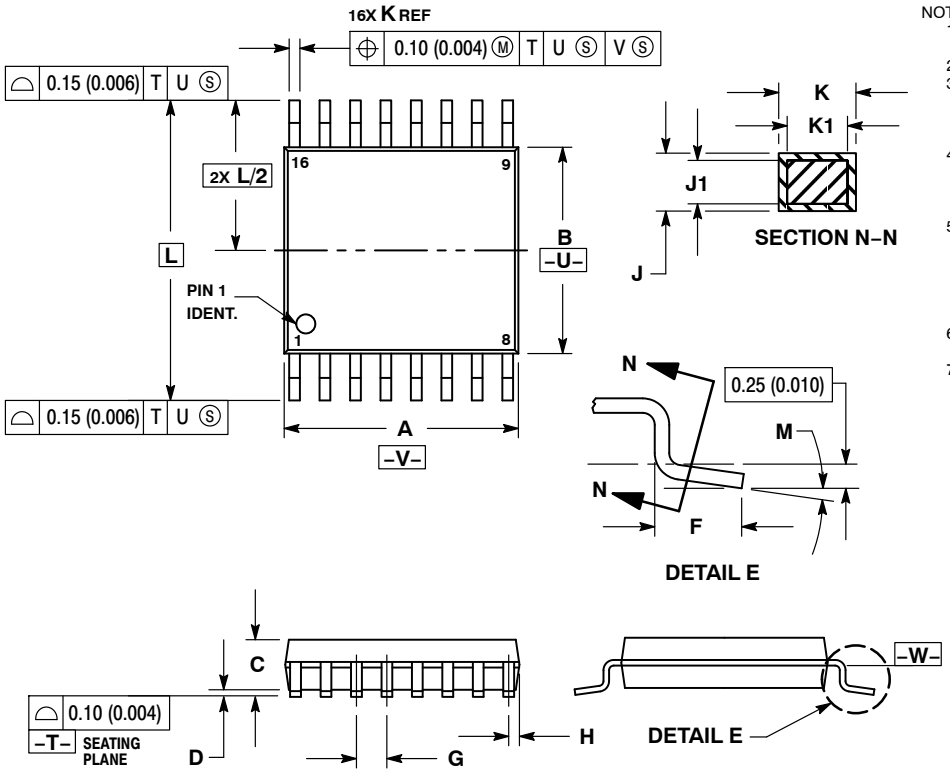
SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

PACKAGE DIMENSIONS

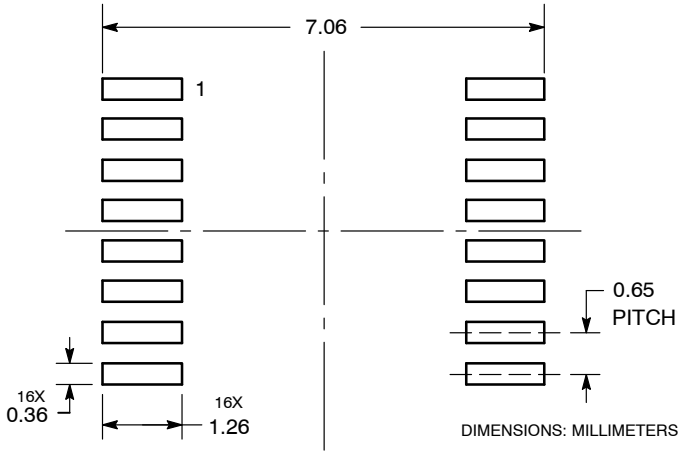
TSSOP−16
DT SUFFIX
CASE 948F−01
ISSUE B



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE −W−.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	−−−	1.20	−−−	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.18	0.28	0.007	0.011
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0 °	8 °	0 °	8 °

SOLDERING FOOTPRINT



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