TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74AC161P,TC74AC161F,TC74AC161FN,TC74AC161FT
TC74AC163P,TC74AC163F,TC74AC163FN,TC74AC163FT

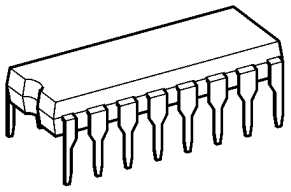
Synchronous Presettable 4-Bit Binary Counter

TC74AC161P/F/FN/FT Asynchronous Clear

TC74AC163P/F/FN/FT Synchronous Clear

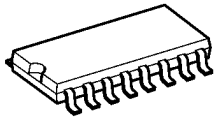
Note: xxxFN (JEDEC SOP) is not available in Japan.

TC74AC161P, TC74AC163P



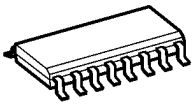
DIP16-P-300-2.54A

TC74AC161F, TC74AC163F



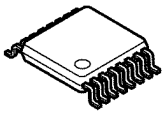
SOP16-P-300-1.27A

TC74AC161FN, TC74AC163FN



SOL16-P-150-1.27

TC74AC161FT, TC74AC163FT



TSSOP16-P-0044-0.65A

Weight

DIP16-P-300-2.54A	: 1.00 g (typ.)
SOP16-P-300-1.27A	: 0.18 g (typ.)
SOL16-P-150-1.27	: 0.13 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)

The TC74AC161 and 163 are advanced high speed CMOS SYNCHRONOUS PRESETTABLE COUNTERs fabricated with silicon gate and double-layer metal wiring C^2MOS technology.

They achieve the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

The CK input is active on the rising edge. Both $\overline{LOAD}$ and $\overline{CLR}$ inputs are active on low logic level.

Presetting of these IC's is synchronous to the rising edge of CK.

The clear function of the TC74AC163 is synchronous to CK, while the TC74AC161 are cleared asynchronously.

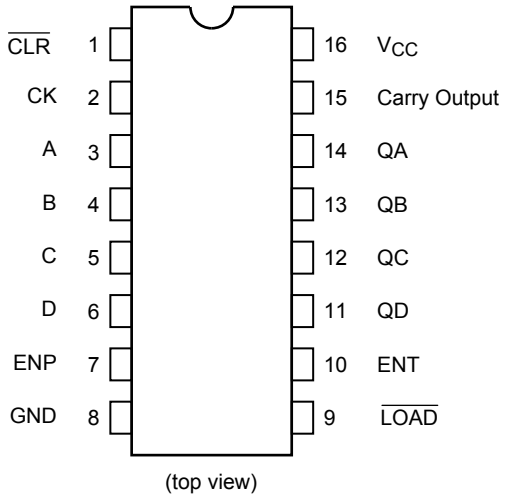
Two enable inputs (ENP and ENT) and CARRY OUTPUT are provided to enable easy cascading of counters, which facilitates easy implementation of n-bit counters without using external gates.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

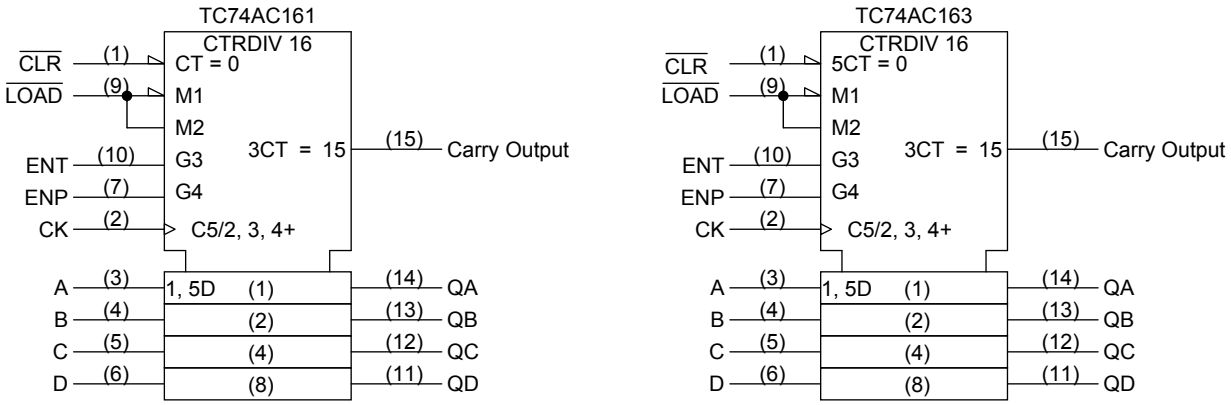
Features

- High speed: f_{max} = 170 MHz (typ.) at V_{CC} = 5 V
- Low power dissipation: I_{CC} = 8 μA (max) at Ta = 25°C
- High noise immunity: $V_{NIH} = V_{NIL}$ = 28% V_{CC} (min)
- Symmetrical output impedance: $|I_{OH}| = I_{OL}$ = 24 mA (min)
  Capability of driving 50 Ω transmission lines.
- Balanced propagation delays: $t_{pLH} \simeq t_{pHL}$
- Wide operating voltage range: $V_{CC\ (opr)}$ = 2 to 5.5 V
- Pin and function compatible with 74F161/163

Pin Assignment



IEC Logic Symbol



Truth Table (Note)

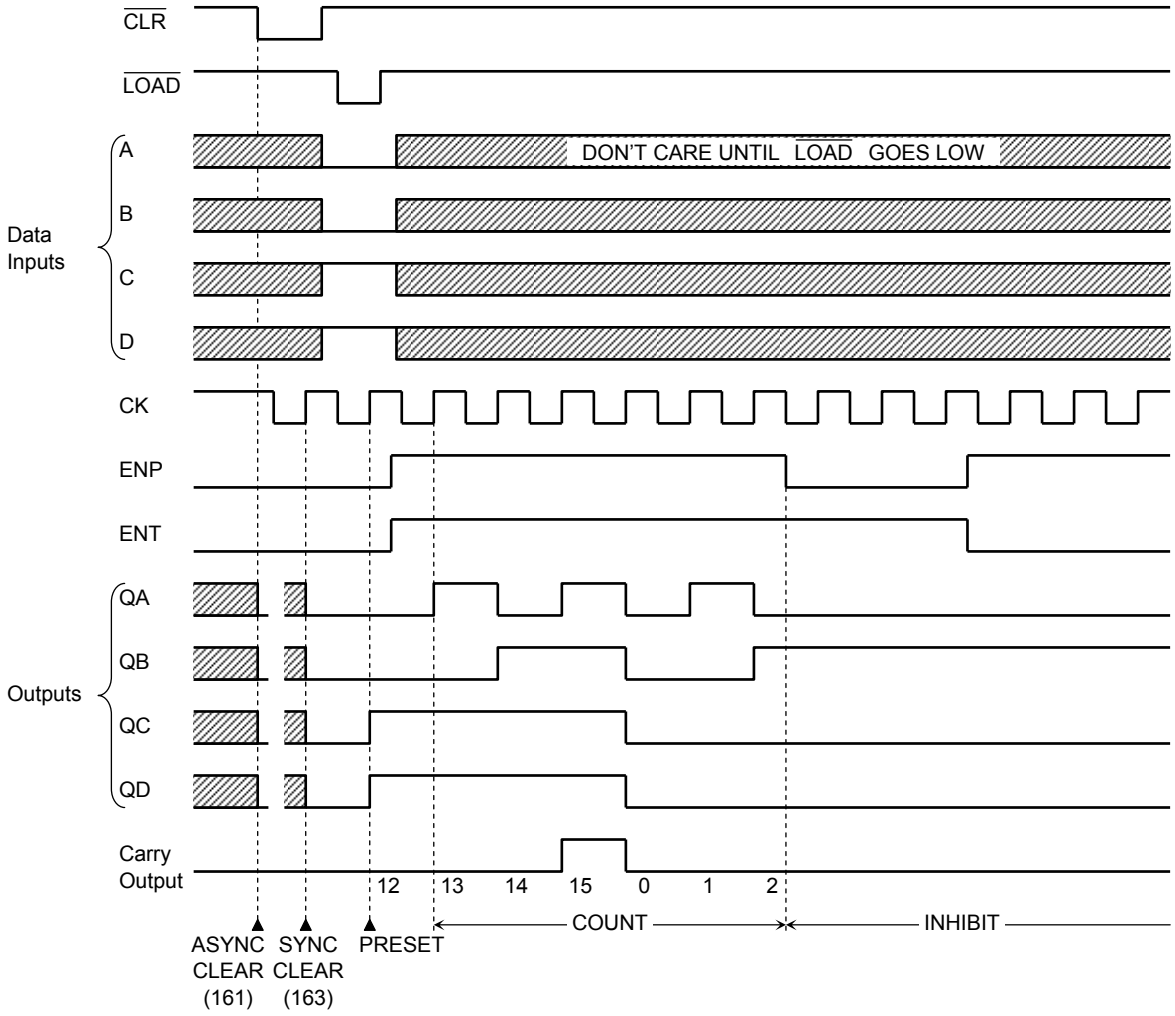
Inputs							Outputs				Function
$\overline{CLR}$ (161)	$\overline{CLR}$ (163)	$\overline{LOAD}$	ENP	ENT	CK (161)	CK (163)	QA	QB	QC	QD	
L	L	X	X	X	X	↑	L	L	L	L	Reset to “0”
H	H	L	X	X	↑	↑	A	B	C	D	Preset Data
H	H	H	X	L	↑	↑	No Change				No Count
H	H	H	L	X	↑	↑	No Change				No Count
H	H	H	H	H	↑	↑	Count Up				Count
H	X	X	X	X	↓	↓	No Change				No Count

Note: X: Don’t care

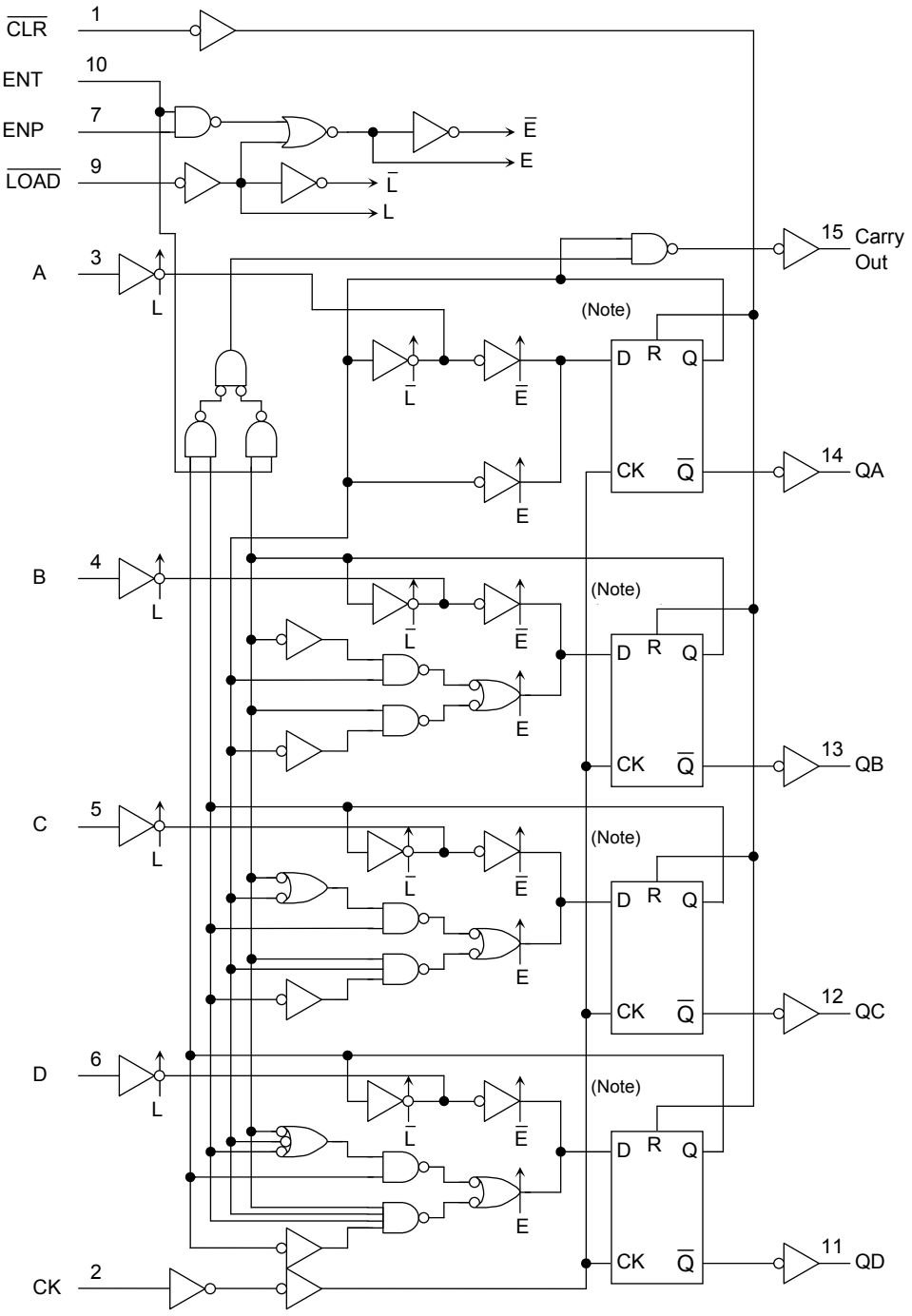
A, B, C, D: Logic level of data inputs

Carry: Carry = ENT·QA·QB·QC·QD

Timing Chart



System Diagram



Note: Truth table of internal F/F

TC74AC161					TC74AC163				
D	CK	R	Q	$\overline{Q}$	D	CK	R	Q	$\overline{Q}$
X	X	H	L	H	X	↑	H	L	H
L	↑	L	L	H	L	↑	L	L	H
H	↑	L	H	L	H	↑	L	H	L
X	↓	L	No Change		X	↓	L	No Change	

X: Don't care

Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V_{CC}	−0.5 to 7.0	V
DC input voltage	V_{IN}	−0.5 to V_{CC} + 0.5	V
DC output voltage	V_{OUT}	−0.5 to V_{CC} + 0.5	V
Input diode current	I_{IK}	±20	mA
Output diode current	I_{OK}	±50	mA
DC output current	I_{OUT}	±50	mA
DC V_{CC}/ground current	I_{CC}	±125	mA
Power dissipation	P_D	500 (DIP) (Note 2)/180 (SOP/TSSOP)	mW
Storage temperature	T_{stg}	−65 to 150	°C

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.
Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/Derating Concept and Methods) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 2: 500 mW in the range of Ta = −40 to 65°C. From Ta = 65 to 85°C a derating factor of −10 mW/°C should be applied up to 300 mW.

Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	2.0 to 5.5	V
Input voltage	V_{IN}	0 to V_{CC}	V
Output voltage	V_{OUT}	0 to V_{CC}	V
Operating temperature	T_{opr}	−40 to 85	°C
Input rise and fall time	dt/dV	0 to 100 (V_{CC} = 3.3 ± 0.3 V) 0 to 20 (V_{CC} = 5 ± 0.5 V)	ns/V

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either VCC or GND.

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition		V_{CC} (V)	Ta = 25°C Min	Ta = 25°C Typ.	Ta = 25°C Max	Ta = −40 to 85°C Min	Ta = −40 to 85°C Max	Unit
High-level input voltage	V_{IH}	—		2.0	1.50	—	—	1.50	—	V
				3.0	2.10	—	—	2.10	—	
				5.5	3.85	—	—	3.85	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.50	—	0.50	V
				3.0	—	—	0.90	—	0.90	
				5.5	—	—	1.65	—	1.65	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −50 μA	2.0	1.9	2.0	—	1.9	—	V
				3.0	2.9	3.0	—	2.9	—	
				4.5	4.4	4.5	—	4.4	—	
			I_{OH} = −4 mA	3.0	2.58	—	—	2.48	—	
			I_{OH} = −24 mA	4.5	3.94	—	—	3.80	—	
			I_{OH} = −75 mA (Note)	5.5	—	—	—	3.85	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA	2.0	—	0.0	0.1	—	0.1	V
				3.0	—	0.0	0.1	—	0.1	
				4.5	—	0.0	0.1	—	0.1	
			I_{OL} = 12 mA	3.0	—	—	0.36	—	0.44	
			I_{OL} = 24 mA	4.5	—	—	0.36	—	0.44	
			I_{OL} = 75 mA (Note)	5.5	—	—	—	—	1.65	
Input leakage current	I_{IN}	V_{IN} = V_{CC} or GND		5.5	—	—	±0.1	—	±1.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	—	8.0	—	80.0	μA

Note: This spec indicates the capability of driving 50 Ω transmission lines.

One output should be tested at a time for a 10 ms maximum duration.

Timing Requirements (input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition		Ta = 25°C	Ta = −40 to 85°C	Unit
			V_{CC} (V)	Limit	Limit	
Minimum pulse width (CK)	$t_{w\,(L)}$ $t_{w\,(H)}$	Figure 1	3.3 ± 0.3 5.0 ± 0.5	7.0 5.0	7.0 5.0	ns
Minimum pulse width ($\overline{CLR}$) (Note 1)	$t_{w\,(L)}$	Figure 4	3.3 ± 0.3 5.0 ± 0.5	7.0 5.0	7.0 5.0	ns
Minimum set-up time ($\overline{LOAD}$, ENP, ENT)	t_s	Figure 2, Figure 3	3.3 ± 0.3 5.0 ± 0.5	11.0 7.0	13.0 7.0	ns
Minimum set-up time (A, B, C, D)	t_s	Figure 2	3.3 ± 0.3 5.0 ± 0.5	8.0 4.0	8.0 4.0	ns
Minimum set-up time ($\overline{CLR}$) (Note 2)	t_s	Figure 5	3.3 ± 0.3 5.0 ± 0.5	6.0 4.0	6.0 4.0	ns
Minimum hold time	t_h	Figure 2, Figure 3, Figure 5	3.3 ± 0.3 5.0 ± 0.5	1.0 1.0	1.0 1.0	ns
Minimum removal time ($\overline{CLR}$) (Note 1)	t_{rem}	Figure 4	3.3 ± 0.3 5.0 ± 0.5	6.0 4.0	6.0 4.0	ns

Note 1: For TC74AC161 only

Note 2: For TC74AC163 only

AC Characteristics (C_L = 50 pF, R_L = 500 Ω, input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = −40 to 85°C		Unit
			V_{CC} (V)	Min	Typ.	Max	Min	Max	
Propagation delay time (CK-Q)	t_{pLH} t_{pHL}	Figure 1	3.3 ± 0.3 5.0 ± 0.5	— —	8.8 6.5	15.8 9.6	1.0 1.0	18.0 11.0	ns
Propagation delay time (CK-carry, count mode)	t_{pLH} t_{pHL}	Figure 1	3.3 ± 0.3 5.0 ± 0.5	— —	10.4 8.1	18.4 11.8	1.0 1.0	21.6 13.5	ns
Propagation delay time (CK-carry, preset mode)	t_{pLH} t_{pHL}	Figure 2	3.3 ± 0.3 5.0 ± 0.5	— —	12.9 9.1	22.4 13.2	1.0 1.0	25.5 15.0	ns
Propagation delay time (ENT-carry)	t_{pLH} t_{pHL}	Figure 6	3.3 ± 0.3 5.0 ± 0.5	— —	7.5 5.8	13.2 8.3	1.0 1.0	15.0 9.5	ns
Propagation delay time ($\overline{CLR}$ -Q) (Note 1)	t_{pHL}	Figure 4	3.3 ± 0.3 5.0 ± 0.5	— —	10.6 7.7	18.4 11.4	1.0 1.0	21.0 13.0	ns
Propagation delay time ($\overline{CLR}$ -carry) (Note 1)	t_{pHL}	Figure 4	3.3 ± 0.3 5.0 ± 0.5	— —	12.0 8.6	21.0 12.7	1.0 1.0	24.0 14.5	ns
Maximum clock frequency	f_{max}	—	3.3 ± 0.3 5.0 ± 0.5	50 90	110 140	— —	50 90	— —	MHz
Input capacitance	C_{IN}	—		—	5	10	—	10	pF
Power dissipation capacitance	C_{PD}	(Note 2		—	85	—	—	—	pF

Note 1: For TC74AC161 only

Note 2: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

When the outputs drive a capacitive load, total current consumption is the sum of C_{PD}, and ΔI_{CC} which is obtained from the following formula:

$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \left(\frac{C_{QA}}{2} + \frac{C_{QB}}{4} + \frac{C_{QC}}{8} + \frac{C_{QD}}{16} + \frac{C_{CO}}{16} \right)$$

C_{QA} to C_{QD} and C_{CO} are the capacitances at QA to QD and CARRY OUT, respectively.

f_{CK} is the input frequency of the CK.

Switching Characteristics Test Waveform

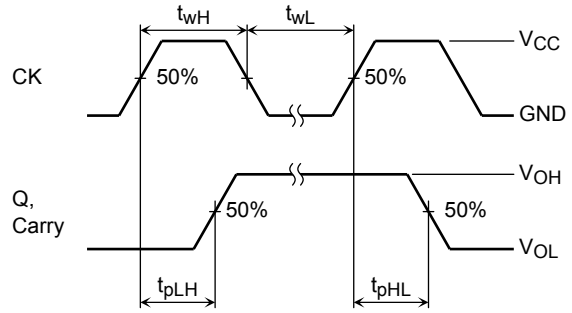


Figure 1 Count Mode

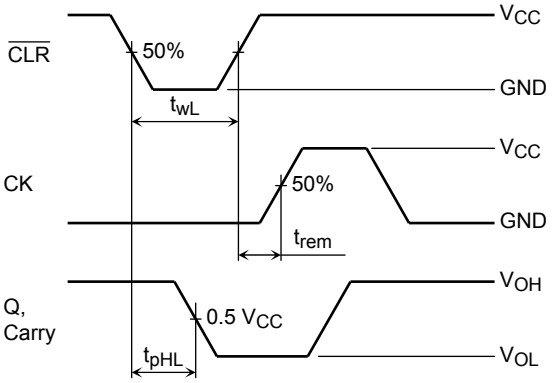


Figure 4 Clear Mode (TC74AC161)

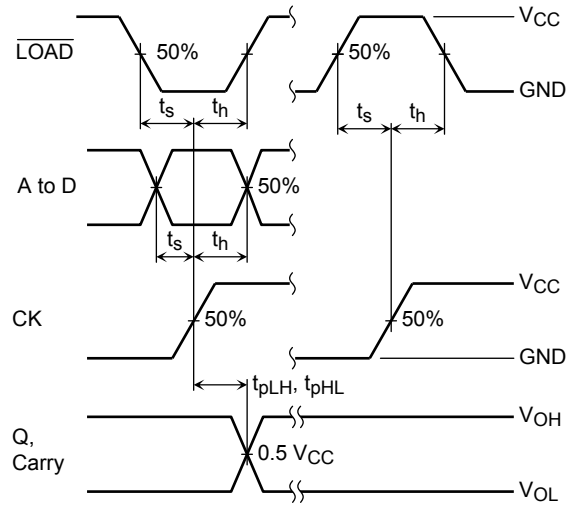


Figure 2 Preset Mode

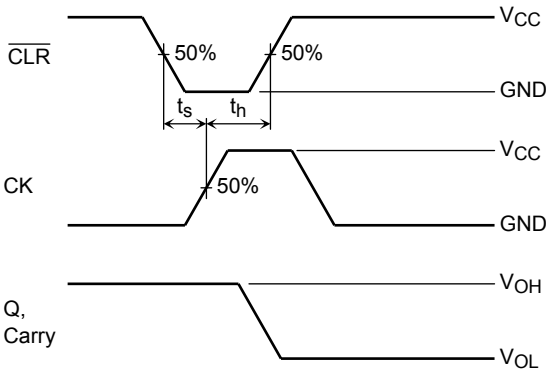


Figure 5 Clear Mode (TC74AC163)

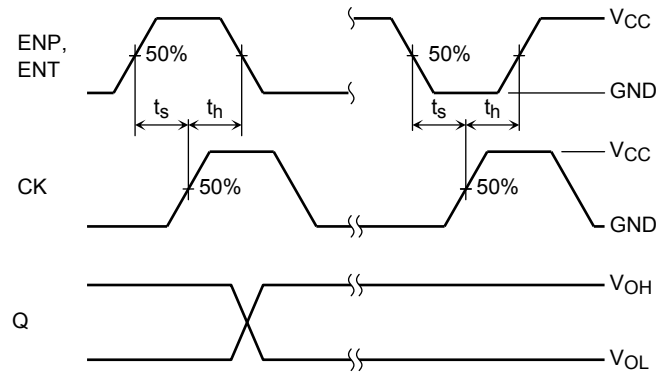


Figure 3 Count Enable Mode

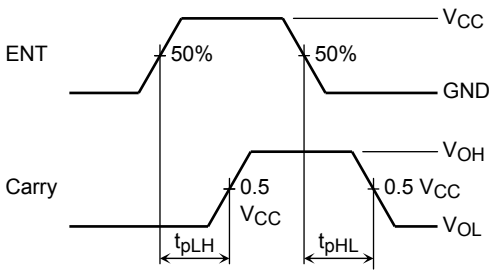
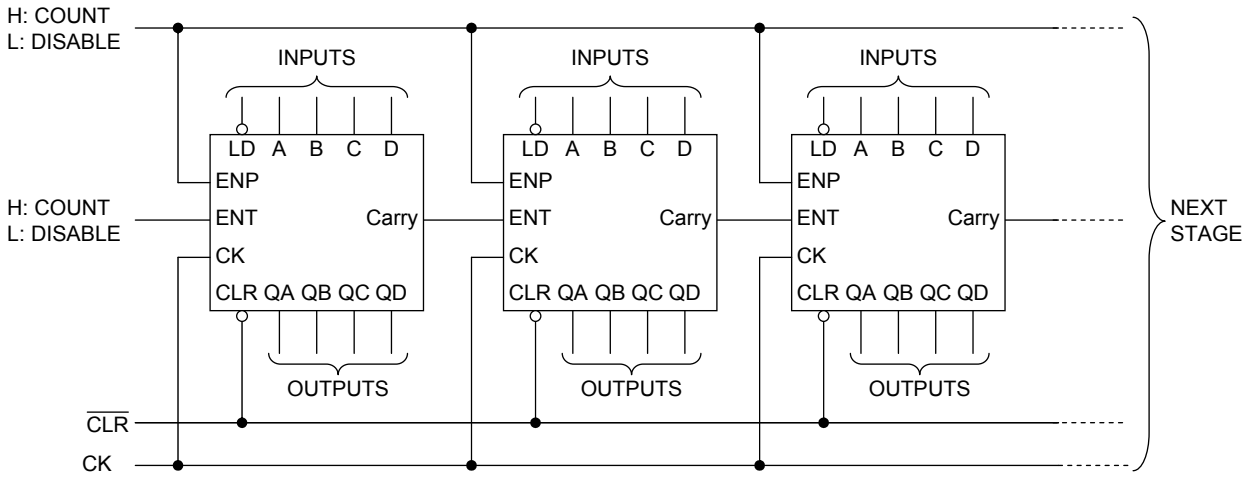


Figure 6 Cascade Mode (fix maximum count)

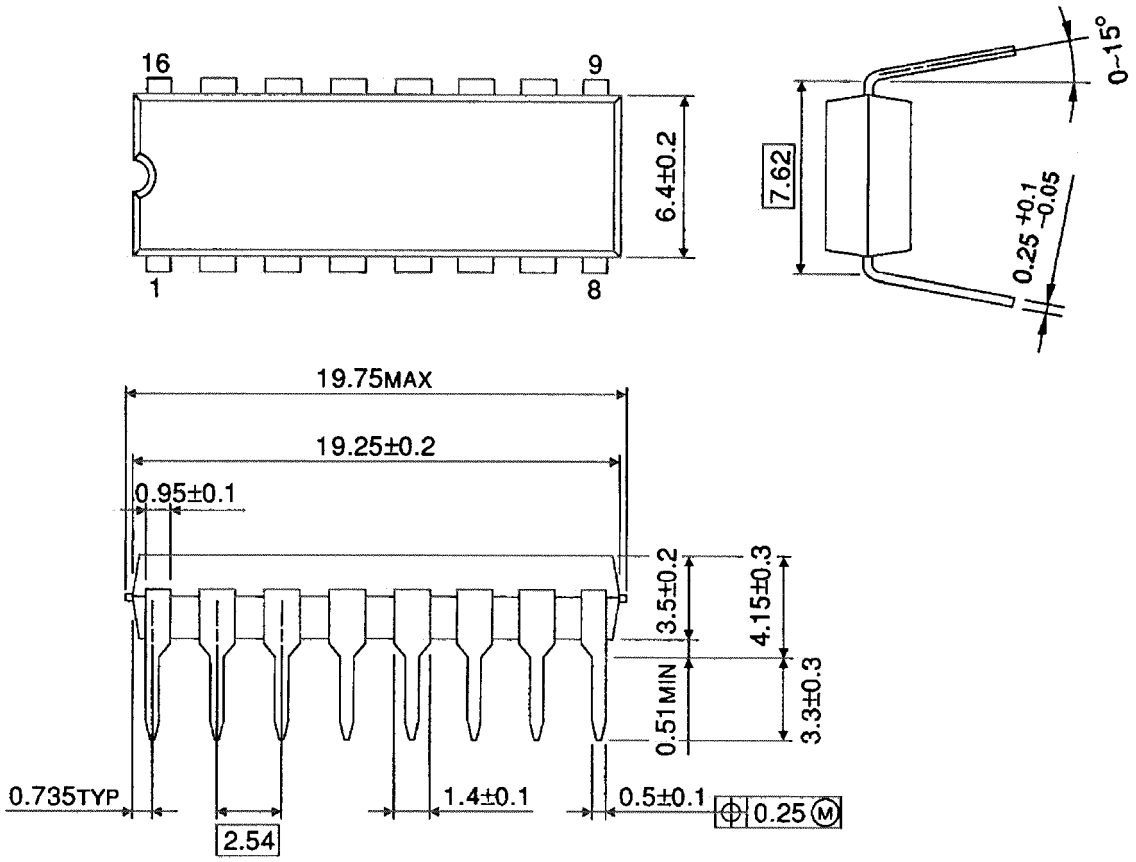
Typical Application

Parallel Carry N-Bit Counter



Package Dimensions

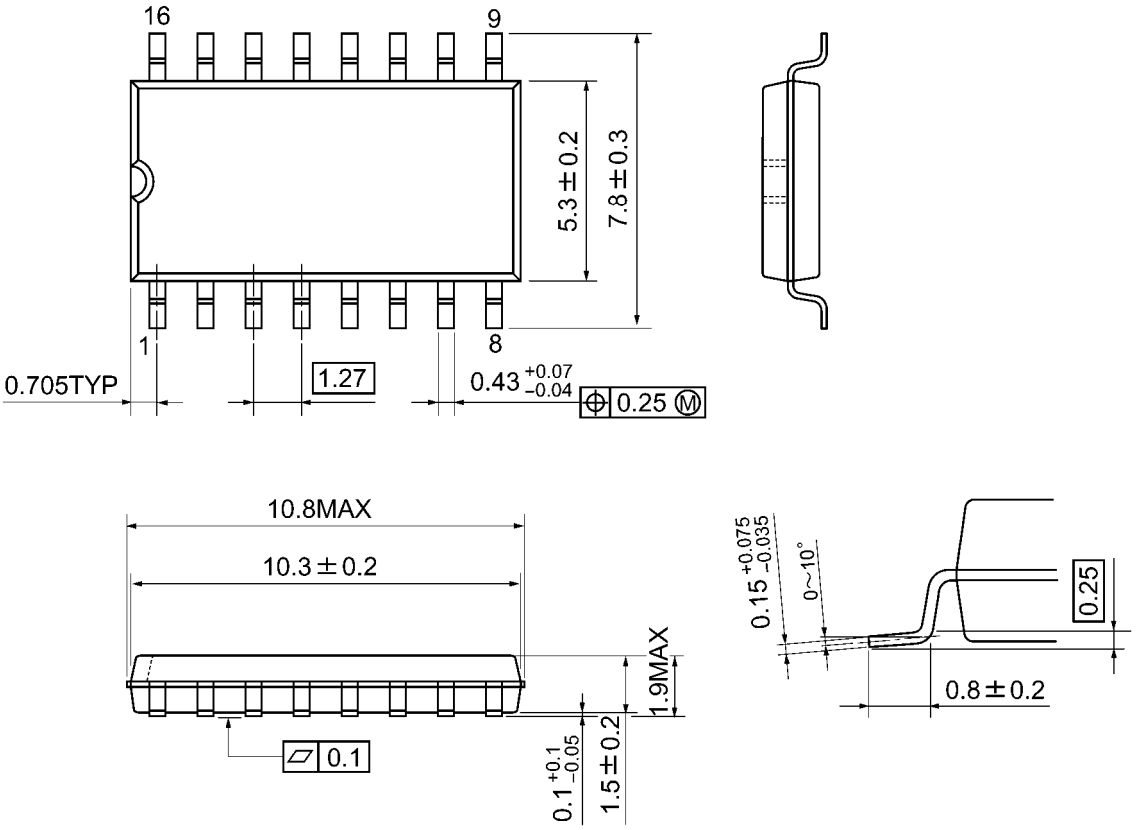
DIP16-P-300-2.54A Unit : mm



Weight: 1.00 g (typ.)

Package Dimensions

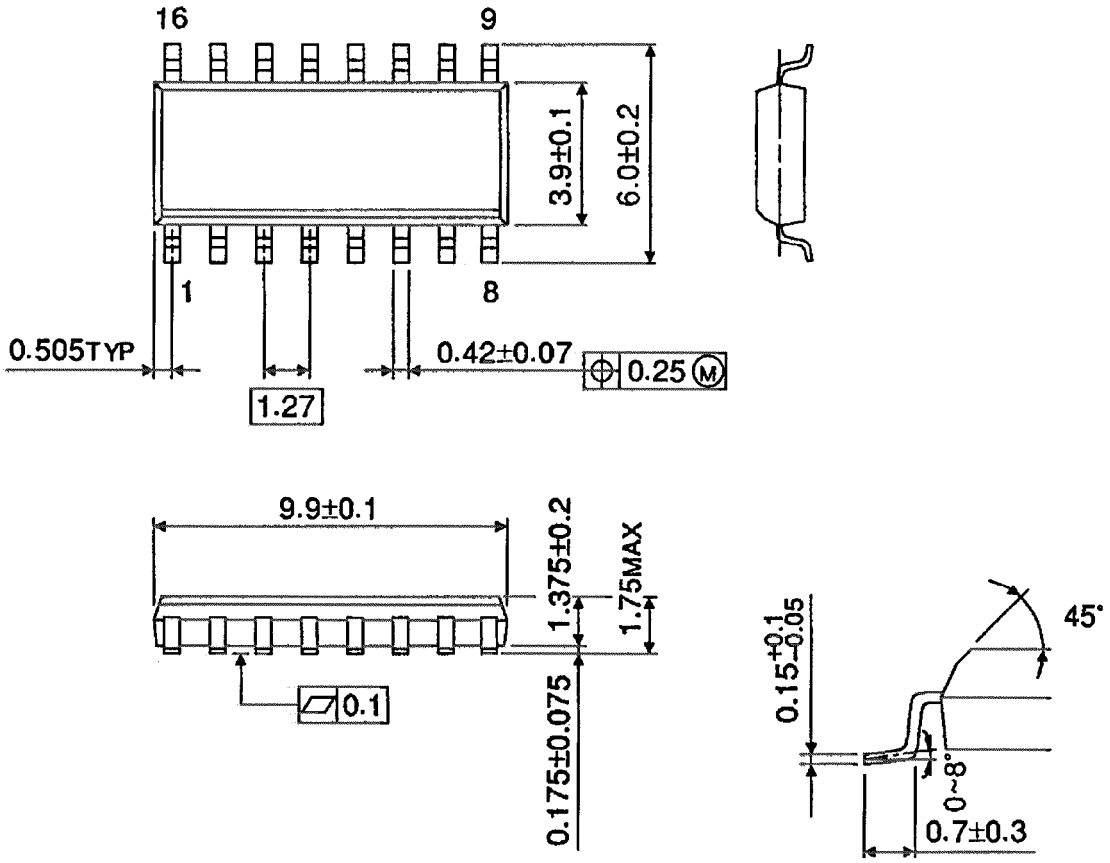
SOP16-P-300-1.27A Unit: mm



Weight: 0.18 g (typ.)

Package Dimensions (Note)

SOL16-P-150-1.27 Unit : mm

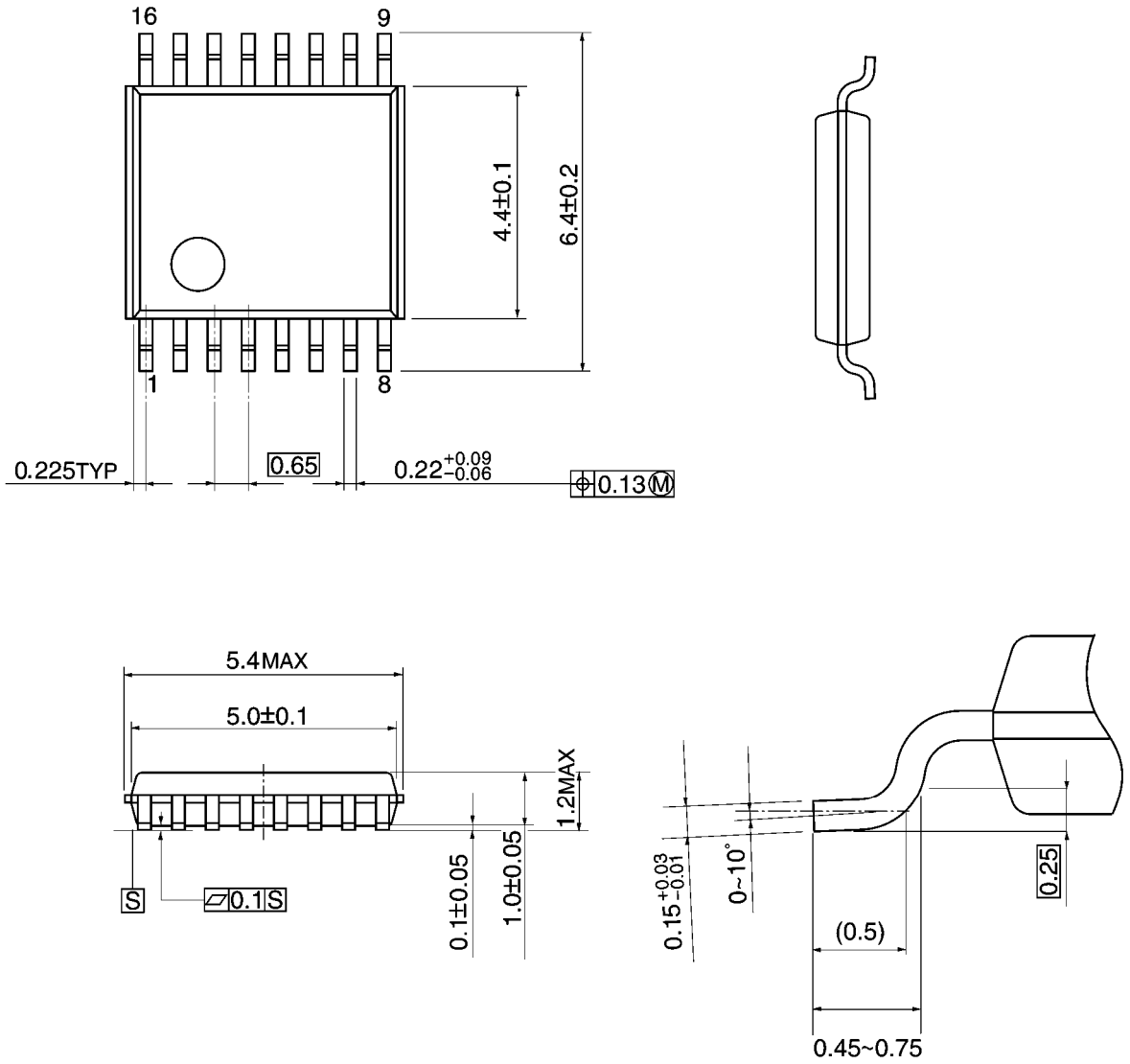


Note: This package is not available in Japan.

Weight: 0.13 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A Unit: mm



Weight: 0.06 g (typ.)