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# 74VHC161FT,74VHC163FT

## 1. Functional Description

- Synchronous Presettable 4-Bit Counter  
74VHC161FT: Binary , Asynchronous Clear  
74VHC163FT: Binary , Synchronous Clear

## 2. General

The 74VHC161FT and 74VHC163FT are advanced high speed CMOS SYNCHRONOUS PRESETTABLE 4 BIT BINARY COUNTERs fabricated with silicon gate C<sup>2</sup>MOS 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 each IC's is synchronous to the rising edge of CK.

The clear function of the 74VHC163FT is synchronous to CK, while the 74VHC161FT 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.

An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up.

This circuit prevents device destruction due to mismatched supply and input voltages

## 3. Features

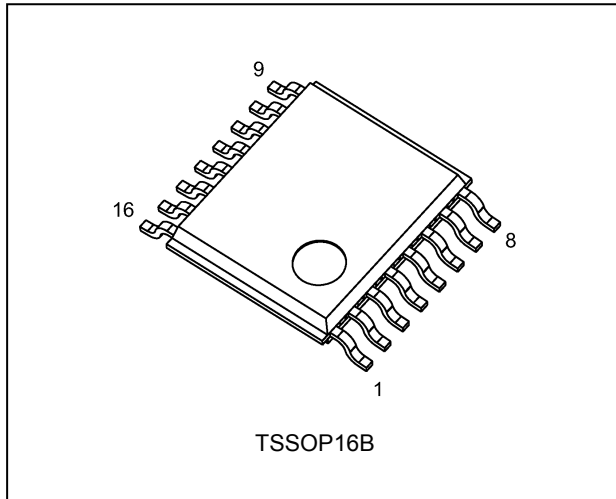
- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C
- (3) High speed:  $f_{MAX} = 185$  MHz (typ.) at  $V_{CC} = 5$  V
- (4) Low power dissipation:  $I_{CC} = 4.0$   $\mu$ A (max) at  $T_a = 25$  °C
- (5) High noise immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (min)
- (6) Power-down protection is provided on all inputs.
- (7) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range:  $V_{CC(opr)} = 2.0$  V to  $5.5$  V
- (9) Low noise:  $V_{OLP} = 0.8$  V (max)
- (10) Pin and function compatible with 74 series (AC/HC/AHC/LV etc.) 161 or 163 type.

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

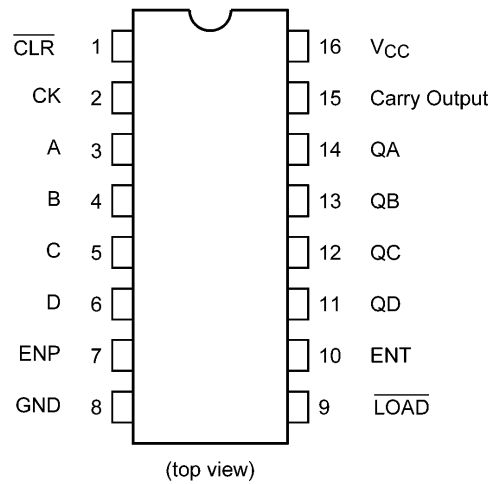
Start of commercial production

2014-12

**4. Packaging**

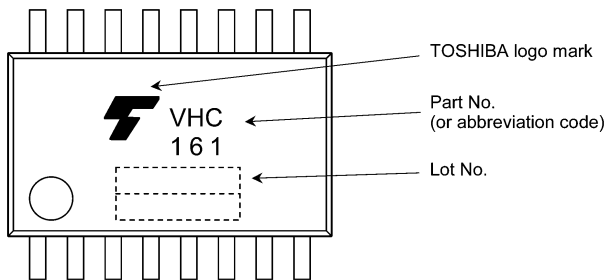


**5. Pin Assignment**

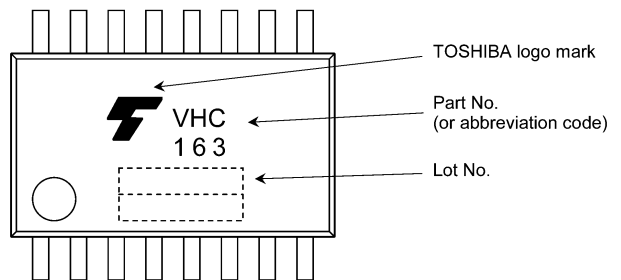


**6. Marking**

74VHC161FT

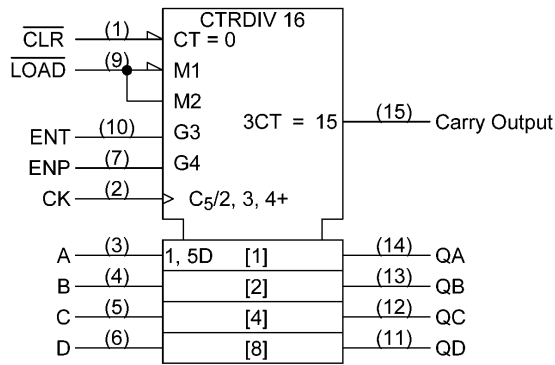


74VHC163FT

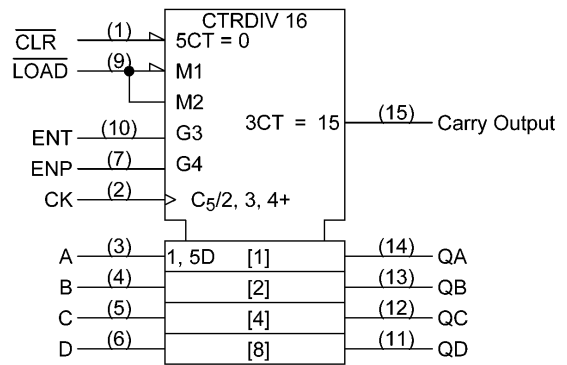


**7. IEC Logic Symbol**

74VHC161FT



74VHC163FT



**8. Truth Table**

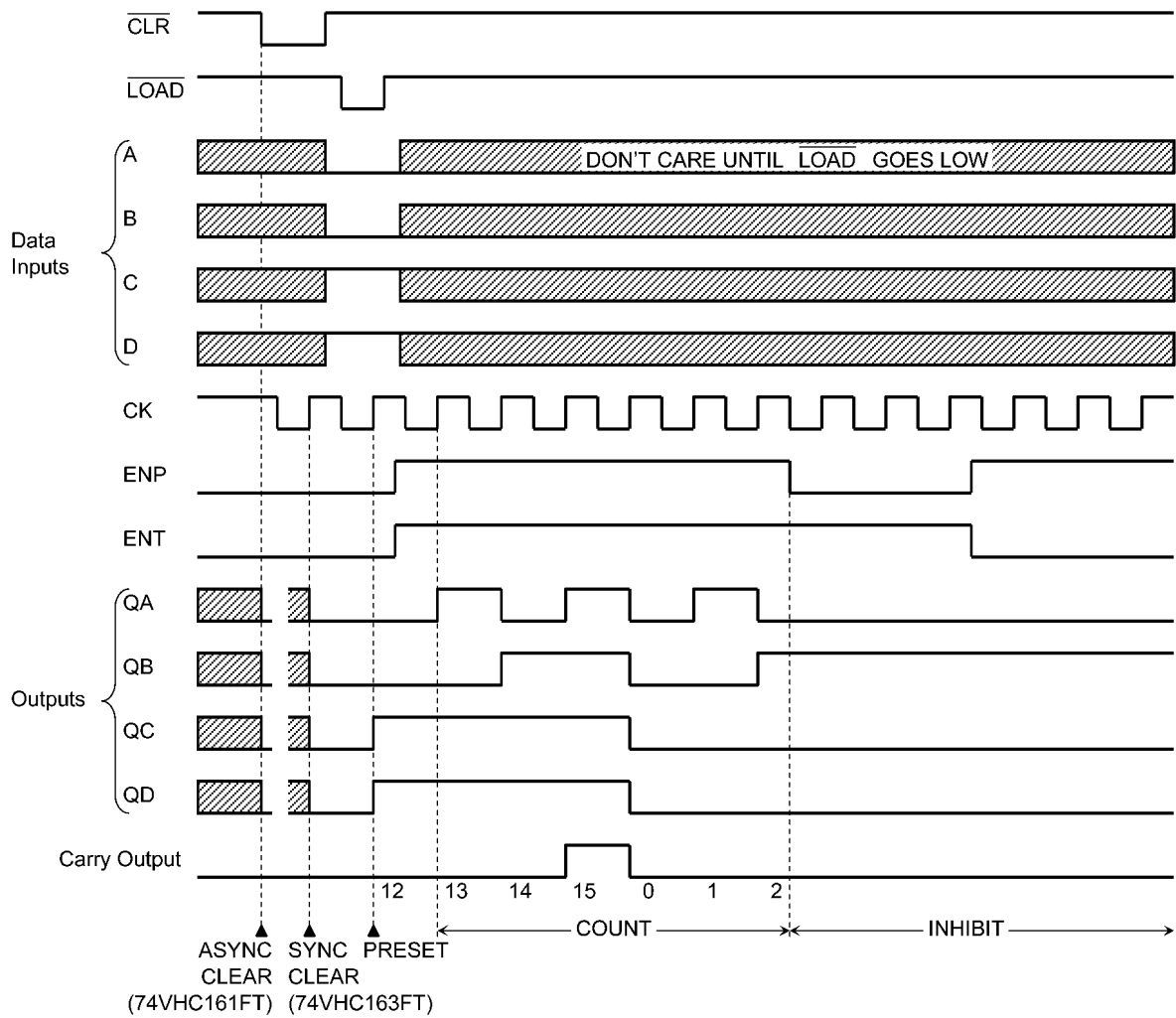
| 74VHC161FT |      |     |     |    | 74VHC163FT |      |     |     |    | Outputs   |    |    |    | Function     |
|------------|------|-----|-----|----|------------|------|-----|-----|----|-----------|----|----|----|--------------|
| Inputs     |      |     |     |    | Inputs     |      |     |     |    | QA        | QB | QC | QD |              |
| CLR        | LOAD | ENP | ENT | CK | CLR        | LOAD | ENP | ENT | CK | QA        | QB | QC | QD |              |
| L          | X    | X   | X   | X  | L          | X    | X   | X   | ↑  | L         | L  | L  | L  | Reset to "0" |
| H          | L    | X   | X   | ↑  | H          | L    | X   | X   | ↑  | A         | B  | C  | D  | Preset Data  |
| H          | H    | X   | L   | ↑  | H          | H    | X   | L   | ↑  | No Change |    |    |    | No Count     |
| H          | H    | L   | X   | ↑  | H          | H    | L   | X   | ↑  | No Change |    |    |    | No Count     |
| H          | H    | H   | H   | ↑  | H          | H    | H   | H   | ↑  | Count Up  |    |    |    | Count        |
| H          | X    | X   | X   | ↓  | X          | X    | X   | X   | ↓  | No Change |    |    |    | No Count     |

X: Don't care

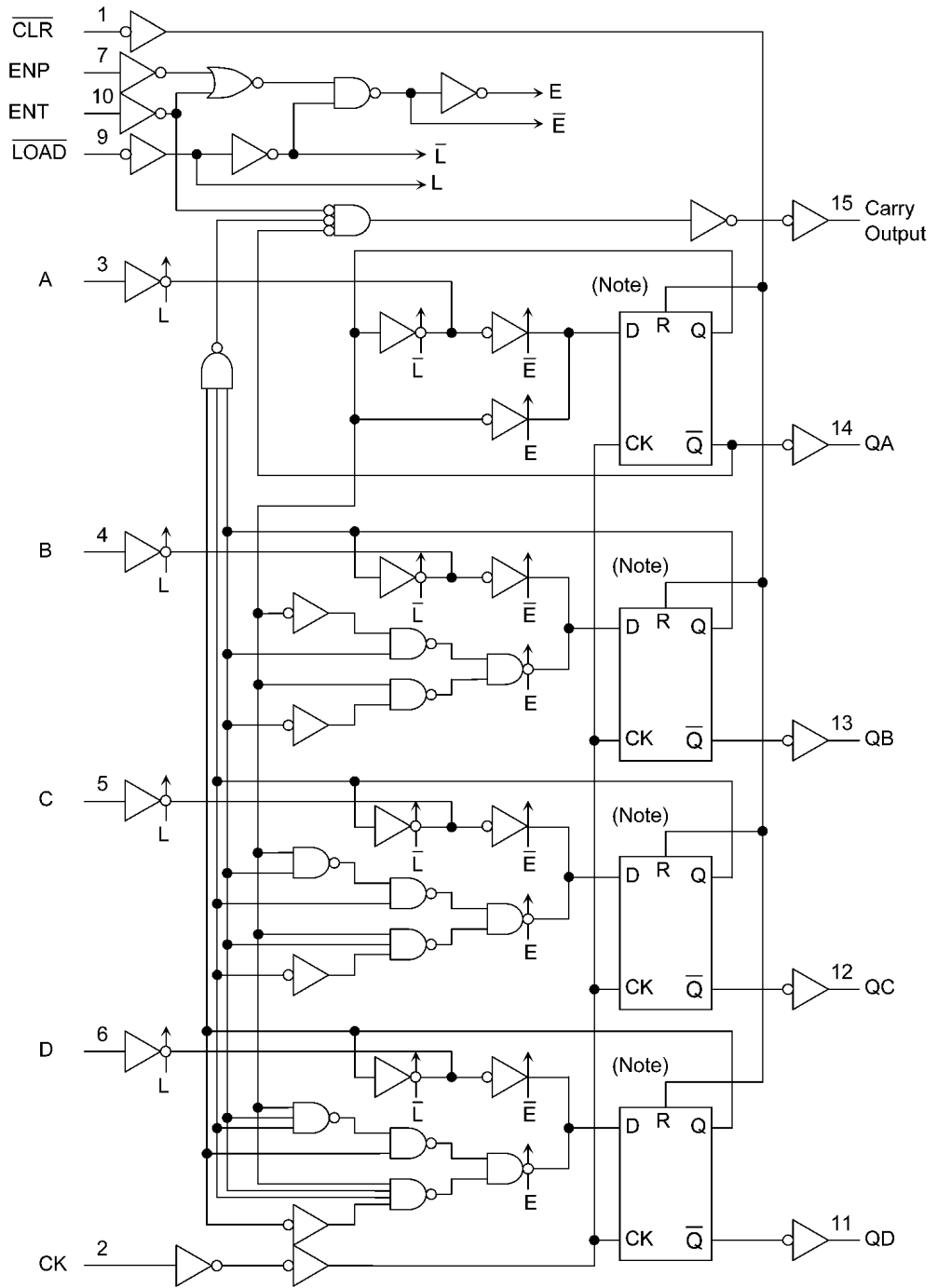
A, B, C, D: Logic level of data inputs

Carry: Carry = ENT · QA · QB · QC · QD

**9. Timing Diagrams**



10. System Diagram



Note: Truth table of internal F/F

| 74VHC161FT |              |   |           |           | 74VHC163FT |              |   |           |           |
|------------|--------------|---|-----------|-----------|------------|--------------|---|-----------|-----------|
| D          | CK           | R | Q         | $\bar{Q}$ | D          | CK           | R | Q         | $\bar{Q}$ |
| X          | X            | H | L         | H         | X          | $\uparrow$   | H | L         | H         |
| L          | $\uparrow$   | L | L         | H         | L          | $\uparrow$   | L | L         | H         |
| H          | $\uparrow$   | L | H         | L         | H          | $\uparrow$   | L | H         | L         |
| X          | $\downarrow$ | L | No Change |           | X          | $\downarrow$ | X | No Change |           |

X: Don't care

**11. Absolute Maximum Ratings (Note)**

| Characteristics          | Symbol    | Note     | Rating                 | Unit |
|--------------------------|-----------|----------|------------------------|------|
| Supply voltage           | $V_{CC}$  |          | -0.5 to 7.0            | V    |
| Input voltage            | $V_{IN}$  |          | -0.5 to 7.0            | V    |
| Output voltage           | $V_{OUT}$ |          | -0.5 to $V_{CC} + 0.5$ | V    |
| Input diode current      | $I_{IK}$  |          | -20                    | mA   |
| Output diode current     | $I_{OK}$  |          | $\pm 20$               | mA   |
| Output current           | $I_{OUT}$ |          | $\pm 25$               | mA   |
| $V_{CC}$ /ground current | $I_{CC}$  |          | $\pm 50$               | mA   |
| Power dissipation        | $P_D$     | (Note 1) | 180                    | mW   |
| Storage temperature      | $T_{stg}$ |          | -65 to 150             | °C   |

Note: 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 1: 180 mW in the range of  $T_a = -40$  to  $85$  °C. From  $T_a = 85$  to  $125$  °C a derating factor of  $-3.25$  mW/°C shall be applied until 50 mW.

**12. Operating Ranges (Note)**

| Characteristics           | Symbol    | Test Condition           | Rating        | Unit |
|---------------------------|-----------|--------------------------|---------------|------|
| Supply voltage            | $V_{CC}$  |                          | 2.0 to 5.5    | V    |
| Input voltage             | $V_{IN}$  |                          | 0 to 5.5      | V    |
| Output voltage            | $V_{OUT}$ |                          | 0 to $V_{CC}$ | V    |
| Operating temperature     | $T_{opr}$ |                          | -40 to 125    | °C   |
| Input rise and fall times | $dt/dv$   | $V_{CC} = 3.3 \pm 0.3$ V | 0 to 100      | ns/V |
|                           |           | $V_{CC} = 5 \pm 0.5$ V   | 0 to 20       |      |

Note: The operating ranges must be maintained to ensure the normal operation of the device.  
Unused inputs must be tied to either  $V_{CC}$  or GND.

**13. Electrical Characteristics**

**13.1. DC Characteristics (Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ )**

| Characteristics           | Symbol   | Test Condition                 | $V_{CC}$ (V)                      | Min                 | Typ. | Max                 | Unit          |   |
|---------------------------|----------|--------------------------------|-----------------------------------|---------------------|------|---------------------|---------------|---|
| High-level input voltage  | $V_{IH}$ | —                              | 2.0                               | 1.50                | —    | —                   | V             |   |
|                           |          |                                | 3.0 to 5.5                        | $V_{CC} \times 0.7$ | —    | —                   |               |   |
| Low-level input voltage   | $V_{IL}$ | —                              | 2.0                               | —                   | —    | 0.50                | V             |   |
|                           |          |                                | 3.0 to 5.5                        | —                   | —    | $V_{CC} \times 0.3$ |               |   |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IH}$ or $V_{IL}$  | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0                 | 1.9  | 2.0                 | —             | V |
|                           |          |                                |                                   | 3.0                 | 2.9  | 3.0                 | —             |   |
|                           |          |                                |                                   | 4.5                 | 4.4  | 4.5                 | —             |   |
|                           |          |                                | $I_{OH} = -4\text{ mA}$           | 3.0                 | 2.58 | —                   | —             |   |
|                           |          |                                | $I_{OH} = -8\text{ mA}$           | 4.5                 | 3.94 | —                   | —             |   |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$  | $I_{OL} = 50\text{ }\mu\text{A}$  | 2.0                 | —    | 0.0                 | 0.1           | V |
|                           |          |                                |                                   | 3.0                 | —    | 0.0                 | 0.1           |   |
|                           |          |                                |                                   | 4.5                 | —    | 0.0                 | 0.1           |   |
|                           |          |                                | $I_{OL} = 4\text{ mA}$            | 3.0                 | —    | —                   | 0.36          |   |
|                           |          |                                | $I_{OL} = 8\text{ mA}$            | 4.5                 | —    | —                   | 0.36          |   |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5\text{ V}$ or GND | 0 to 5.5                          | —                   | —    | $\pm 0.1$           | $\mu\text{A}$ |   |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND       | 5.5                               | —                   | —    | 4.0                 | $\mu\text{A}$ |   |

**13.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85\text{ }^\circ\text{C}$ )**

| Characteristics           | Symbol   | Test Condition                 | $V_{CC}$ (V)                      | Min                 | Max                 | Unit          |   |
|---------------------------|----------|--------------------------------|-----------------------------------|---------------------|---------------------|---------------|---|
| High-level input voltage  | $V_{IH}$ | —                              | 2.0                               | 1.50                | —                   | V             |   |
|                           |          |                                | 3.0 to 5.5                        | $V_{CC} \times 0.7$ | —                   |               |   |
| Low-level input voltage   | $V_{IL}$ | —                              | 2.0                               | —                   | 0.50                | V             |   |
|                           |          |                                | 3.0 to 5.5                        | —                   | $V_{CC} \times 0.3$ |               |   |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IH}$ or $V_{IL}$  | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0                 | 1.9                 | —             | V |
|                           |          |                                |                                   | 3.0                 | 2.9                 | —             |   |
|                           |          |                                |                                   | 4.5                 | 4.4                 | —             |   |
|                           |          |                                | $I_{OH} = -4\text{ mA}$           | 3.0                 | 2.48                | —             |   |
|                           |          |                                | $I_{OH} = -8\text{ mA}$           | 4.5                 | 3.80                | —             |   |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$  | $I_{OL} = 50\text{ }\mu\text{A}$  | 2.0                 | —                   | 0.1           | V |
|                           |          |                                |                                   | 3.0                 | —                   | 0.1           |   |
|                           |          |                                |                                   | 4.5                 | —                   | 0.1           |   |
|                           |          |                                | $I_{OL} = 4\text{ mA}$            | 3.0                 | —                   | 0.44          |   |
|                           |          |                                | $I_{OL} = 8\text{ mA}$            | 4.5                 | —                   | 0.44          |   |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5\text{ V}$ or GND | 0 to 5.5                          | —                   | $\pm 1.0$           | $\mu\text{A}$ |   |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND       | 5.5                               | —                   | 40.0                | $\mu\text{A}$ |   |



**13.3. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $125$  °C)**

| Characteristics           | Symbol   | Test Condition                |                      | $V_{CC}$ (V)     | Min                 | Max                 | Unit    |
|---------------------------|----------|-------------------------------|----------------------|------------------|---------------------|---------------------|---------|
| High-level input voltage  | $V_{IH}$ | —                             |                      | 2.0              | 1.50                | —                   | V       |
|                           |          |                               |                      | 3.0 to 5.5       | $V_{CC} \times 0.7$ | —                   |         |
| Low-level input voltage   | $V_{IL}$ | —                             |                      | 2.0              | —                   | 0.50                | V       |
|                           |          |                               |                      | 3.0 to 5.5       | —                   | $V_{CC} \times 0.3$ |         |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OH} = -50 \mu A$ | 2.0              | 1.9                 | —                   | V       |
|                           |          |                               |                      | 3.0              | 2.9                 | —                   |         |
|                           |          |                               |                      | 4.5              | 4.4                 | —                   |         |
|                           |          |                               |                      | $I_{OH} = -4$ mA | 3.0                 | 2.40                |         |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OL} = 50 \mu A$  | 2.0              | —                   | 0.1                 | V       |
|                           |          |                               |                      | 3.0              | —                   | 0.1                 |         |
|                           |          |                               |                      | 4.5              | —                   | 0.1                 |         |
|                           |          |                               |                      | $I_{OL} = 4$ mA  | 3.0                 | —                   |         |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5$ V or GND       |                      | 0 to 5.5         | —                   | $\pm 2.0$           | $\mu A$ |
|                           |          |                               |                      | 5.5              | —                   | 80.0                |         |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND      |                      | 5.5              | —                   | 80.0                | $\mu A$ |

**13.4. Timing Requirements (Unless otherwise specified,  $T_a = 25$  °C, Input:  $t_r = t_f = 3$  ns)**

| Characteristics              | Symbol               | Note     | Test Condition     | $V_{CC}$ (V)  | Limit | Unit |
|------------------------------|----------------------|----------|--------------------|---------------|-------|------|
| Minimum pulse width (CK)     | $t_{w(L)}, t_{w(H)}$ |          | Figure 1           | $3.3 \pm 0.3$ | 5.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum pulse width (CLR)    | $t_{w(L)}$           | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 5.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum setup time (A,B,C,D) | $t_s$                |          | Figure 2           | $3.3 \pm 0.3$ | 5.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 4.5   |      |
| Minimum setup time (LOAD)    | $t_s$                |          | Figure 2           | $3.3 \pm 0.3$ | 8.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum setup time (ENT,ENP) | $t_s$                |          | Figure 3           | $3.3 \pm 0.3$ | 7.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum setup time (CLR)     | $t_s$                | (Note 2) | Figure 5           | $3.3 \pm 0.3$ | 4.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 3.5   |      |
| Minimum hold time            | $t_h$                |          | Figure 2, Figure 3 | $3.3 \pm 0.3$ | 1.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 1.0   |      |
| Minimum hold time (CLR)      | $t_h$                | (Note 2) | Figure 5           | $3.3 \pm 0.3$ | 1.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 1.5   |      |
| Minimum removal time (CLR)   | $t_{rem}$            | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 2.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 1.5   |      |

Note 1: For 74VHC161FT only

Note 2: For 74VHC163FT only

**13.5. Timing Requirements**  
(Unless otherwise specified,  $T_a = -40$  to  $85$  °C, Input:  $t_r = t_f = 3$  ns)

| Characteristics              | Symbol               | Note     | Test Condition     | $V_{CC}$ (V)  | Limit | Unit |
|------------------------------|----------------------|----------|--------------------|---------------|-------|------|
| Minimum pulse width (CK)     | $t_{w(L)}, t_{w(H)}$ |          | Figure 1           | $3.3 \pm 0.3$ | 5.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum pulse width (CLR)    | $t_{w(L)}$           | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 5.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum setup time (A,B,C,D) | $t_s$                |          | Figure 2           | $3.3 \pm 0.3$ | 6.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 4.5   |      |
| Minimum setup time (LOAD)    | $t_s$                |          | Figure 2           | $3.3 \pm 0.3$ | 9.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 6.0   |      |
| Minimum setup time (ENT,ENP) | $t_s$                |          | Figure 3           | $3.3 \pm 0.3$ | 9.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 6.0   |      |
| Minimum setup time (CLR)     | $t_s$                | (Note 2) | Figure 5           | $3.3 \pm 0.3$ | 4.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 3.5   |      |
| Minimum hold time            | $t_h$                |          | Figure 2, Figure 3 | $3.3 \pm 0.3$ | 1.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 1.0   |      |
| Minimum hold time (CLR)      | $t_h$                | (Note 2) | Figure 5           | $3.3 \pm 0.3$ | 1.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 1.5   |      |
| Minimum removal time (CLR)   | $t_{rem}$            | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 2.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 1.5   |      |

Note 1: For 74VHC161FT only

Note 2: For 74VHC163FT only

**13.6. Timing Requirements**  
(Unless otherwise specified,  $T_a = -40$  to  $125$  °C, Input:  $t_r = t_f = 3$  ns)

| Characteristics              | Symbol               | Note     | Test Condition     | $V_{CC}$ (V)  | Limit | Unit |
|------------------------------|----------------------|----------|--------------------|---------------|-------|------|
| Minimum pulse width (CK)     | $t_{w(L)}, t_{w(H)}$ |          | Figure 1           | $3.3 \pm 0.3$ | 5.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum pulse width (CLR)    | $t_{w(L)}$           | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 5.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum setup time (A,B,C,D) | $t_s$                |          | Figure 2           | $3.3 \pm 0.3$ | 6.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 4.5   |      |
| Minimum setup time (LOAD)    | $t_s$                |          | Figure 2           | $3.3 \pm 0.3$ | 9.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 6.0   |      |
| Minimum setup time (ENT,ENP) | $t_s$                |          | Figure 3           | $3.3 \pm 0.3$ | 9.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 6.0   |      |
| Minimum setup time (CLR)     | $t_s$                | (Note 2) | Figure 5           | $3.3 \pm 0.3$ | 4.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 3.5   |      |
| Minimum hold time            | $t_h$                |          | Figure 2, Figure 3 | $3.3 \pm 0.3$ | 1.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 1.0   |      |
| Minimum hold time (CLR)      | $t_h$                | (Note 2) | Figure 5           | $3.3 \pm 0.3$ | 1.0   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 1.5   |      |
| Minimum removal time (CLR)   | $t_{rem}$            | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 3.5   | ns   |
|                              |                      |          |                    | $5.0 \pm 0.5$ | 2.0   |      |

Note 1: For 74VHC161FT only

Note 2: For 74VHC163FT only

**13.7. AC Characteristics (Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )**

| Characteristics                                  | Symbol             | Note     | Test Condition     | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Typ. | Max  | Unit |
|--|--------------------|----------|--------------------|---------------|------------|-----|------|------|------|
| Propagation delay time (CK - Q)                  | $t_{PLH}, t_{PHL}$ |          | Figure 1, Figure 2 | $3.3 \pm 0.3$ | 15         | —   | 8.3  | 12.8 | ns   |
|  |                    |          |                    |               | 50         | —   | 10.8 | 16.3 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | —   | 4.9  | 8.1  |      |
|  |                    |          |                    |               | 50         | —   | 6.4  | 10.1 |      |
| Propagation delay time (CK - CARRY, count-mode)  | $t_{PLH}, t_{PHL}$ |          | Figure 1           | $3.3 \pm 0.3$ | 15         | —   | 8.7  | 13.6 | ns   |
|  |                    |          |                    |               | 50         | —   | 11.2 | 17.1 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | —   | 4.9  | 8.1  |      |
|  |                    |          |                    |               | 50         | —   | 6.4  | 10.1 |      |
| Propagation delay time (CK - CARRY, preset-mode) | $t_{PLH}, t_{PHL}$ |          | Figure 2           | $3.3 \pm 0.3$ | 15         | —   | 11.0 | 17.2 | ns   |
|  |                    |          |                    |               | 50         | —   | 13.5 | 20.7 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | —   | 6.2  | 10.3 |      |
|  |                    |          |                    |               | 50         | —   | 7.7  | 12.3 |      |
| Propagation delay time (ENT - CARRY)             | $t_{PLH}, t_{PHL}$ |          | Figure 6           | $3.3 \pm 0.3$ | 15         | —   | 7.5  | 12.3 | ns   |
|  |                    |          |                    |               | 50         | —   | 10.5 | 15.8 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | —   | 4.9  | 8.1  |      |
|  |                    |          |                    |               | 50         | —   | 6.4  | 10.1 |      |
| Propagation delay time (CLR - Q)                 | $t_{PHL}$          | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 15         | —   | 8.9  | 13.6 | ns   |
|  |                    |          |                    |               | 50         | —   | 11.2 | 17.1 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | —   | 5.5  | 9.0  |      |
|  |                    |          |                    |               | 50         | —   | 7.0  | 11.0 |      |
| Propagation delay time (CLR - CARRY)             | $t_{PHL}$          | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 15         | —   | 8.4  | 13.2 | ns   |
|  |                    |          |                    |               | 50         | —   | 10.9 | 16.7 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | —   | 5.0  | 8.6  |      |
|  |                    |          |                    |               | 50         | —   | 6.5  | 10.6 |      |
| Maximum clock frequency                          | $f_{MAX}$          |          | —                  | $3.3 \pm 0.3$ | 15         | 80  | 130  | —    | MHz  |
|  |                    |          |                    |               | 50         | 55  | 85   | —    |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 135 | 185  | —    |      |
|  |                    |          |                    |               | 50         | 95  | 125  | —    |      |
| Input capacitance                                | $C_{IN}$           |          | —                  |               |            | —   | 4    | 10   | pF   |
| Power dissipation capacitance                    | $C_{PD}$           | (Note 2) | —                  |               |            | —   | 23   | —    | pF   |

Note 1: For 74VHC161FT 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:

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

When the outputs drive a capacitive load, total current consumption is the sum of  $I_{CC(opr)}$  and  $\Delta I_{CC}$  which is obtained from the following formula:

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

$C_{QA}$  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.

**13.8. AC Characteristics**  
 (Unless otherwise specified,  $T_a = -40$  to  $85$  °C, Input:  $t_r = t_f = 3$  ns)

| Characteristics                                      | Symbol             | Note     | Test Condition     | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Max  | Unit |
|--|--------------------|----------|--------------------|---------------|------------|-----|------|------|
| Propagation delay time<br>(CK - Q)                   | $t_{PLH}, t_{PHL}$ |          | Figure 1, Figure 2 | $3.3 \pm 0.3$ | 15         | 1.0 | 15.0 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 18.5 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 9.5  |      |
|  |                    |          |                    |               | 50         | 1.0 | 11.5 |      |
| Propagation delay time<br>(CK - CARRY , count-mode)  | $t_{PLH}, t_{PHL}$ |          | Figure 1           | $3.3 \pm 0.3$ | 15         | 1.0 | 16.0 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 19.5 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 9.5  |      |
|  |                    |          |                    |               | 50         | 1.0 | 11.5 |      |
| Propagation delay time<br>(CK - CARRY , preset-mode) | $t_{PLH}, t_{PHL}$ |          | Figure 2           | $3.3 \pm 0.3$ | 15         | 1.0 | 20.0 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 23.5 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 12.0 |      |
|  |                    |          |                    |               | 50         | 1.0 | 14.0 |      |
| Propagation delay time<br>(ENT - CARRY)              | $t_{PLH}, t_{PHL}$ |          | Figure 6           | $3.3 \pm 0.3$ | 15         | 1.0 | 14.5 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 18.0 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 9.5  |      |
|  |                    |          |                    |               | 50         | 1.0 | 11.5 |      |
| Propagation delay time<br>(CLR - Q)                  | $t_{PHL}$          | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 15         | 1.0 | 16.0 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 19.5 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 10.5 |      |
|  |                    |          |                    |               | 50         | 1.0 | 12.5 |      |
| Propagation delay time<br>(CLR - CARRY)              | $t_{PHL}$          | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 15         | 1.0 | 15.5 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 19.0 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 10.0 |      |
|  |                    |          |                    |               | 50         | 1.0 | 12.0 |      |
| Maximum clock frequency                              | $f_{MAX}$          |          | —                  | $3.3 \pm 0.3$ | 15         | 70  | —    | MHz  |
|  |                    |          |                    |               | 50         | 50  | —    |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 115 | —    |      |
|  |                    |          |                    |               | 50         | 85  | —    |      |
| Input capacitance                                    | $C_{IN}$           |          | —                  |               |            | —   | 10   | pF   |

Note 1: For 74VHC161FT only

**13.9. AC Characteristics**  
 (Unless otherwise specified,  $T_a = -40$  to  $125$  °C, Input:  $t_r = t_f = 3$  ns)

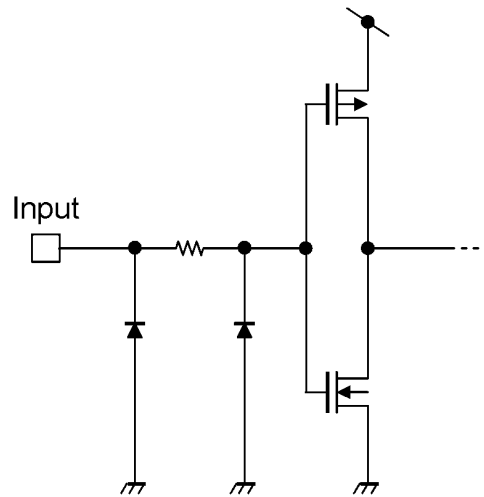
| Characteristics                                      | Symbol             | Note     | Test Condition     | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Max  | Unit |
|--|--------------------|----------|--------------------|---------------|------------|-----|------|------|
| Propagation delay time<br>(CK - Q)                   | $t_{PLH}, t_{PHL}$ |          | Figure 1, Figure 2 | $3.3 \pm 0.3$ | 15         | 1.0 | 17.0 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 20.5 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 11.0 |      |
|  |                    |          |                    |               | 50         | 1.0 | 13.0 |      |
| Propagation delay time<br>(CK - CARRY , count-mode)  | $t_{PLH}, t_{PHL}$ |          | Figure 1           | $3.3 \pm 0.3$ | 15         | 1.0 | 18.0 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 21.5 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 11.0 |      |
|  |                    |          |                    |               | 50         | 1.0 | 13.0 |      |
| Propagation delay time<br>(CK - CARRY , preset-mode) | $t_{PLH}, t_{PHL}$ |          | Figure 2           | $3.3 \pm 0.3$ | 15         | 1.0 | 22.5 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 26.0 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 13.5 |      |
|  |                    |          |                    |               | 50         | 1.0 | 15.5 |      |
| Propagation delay time<br>(ENT - CARRY)              | $t_{PLH}, t_{PHL}$ |          | Figure 6           | $3.3 \pm 0.3$ | 15         | 1.0 | 16.5 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 20.0 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 11.0 |      |
|  |                    |          |                    |               | 50         | 1.0 | 13.0 |      |
| Propagation delay time<br>(CLR - Q)                  | $t_{PHL}$          | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 15         | 1.0 | 18.0 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 21.5 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 12.0 |      |
|  |                    |          |                    |               | 50         | 1.0 | 14.0 |      |
| Propagation delay time<br>(CLR - CARRY)              | $t_{PHL}$          | (Note 1) | Figure 4           | $3.3 \pm 0.3$ | 15         | 1.0 | 17.5 | ns   |
|  |                    |          |                    |               | 50         | 1.0 | 21.0 |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 11.5 |      |
|  |                    |          |                    |               | 50         | 1.0 | 13.5 |      |
| Maximum clock frequency                              | $f_{MAX}$          |          | —                  | $3.3 \pm 0.3$ | 15         | 60  | —    | MHz  |
|  |                    |          |                    |               | 50         | 40  | —    |      |
|  |                    |          |                    | $5.0 \pm 0.5$ | 15         | 105 | —    |      |
|  |                    |          |                    |               | 50         | 75  | —    |      |
| Input capacitance                                    | $C_{IN}$           |          | —                  |               |            | —   | 10   | pF   |

Note 1: For 74VHC161FT only

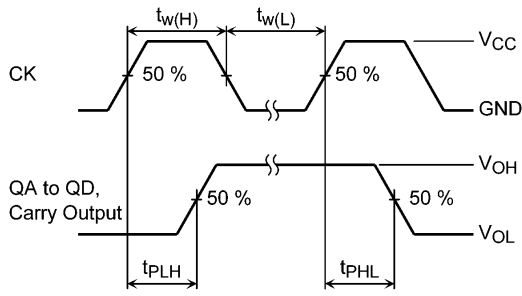
**14. Noise Characteristics (Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )**

| Characteristics                          | Symbol    | Test Condition       | $V_{CC}$ (V) | Typ. | Limit | Unit |
|--|-----------|----------------------|--------------|------|-------|------|
| Quiet output maximum dynamic $V_{OL}$    | $V_{OLP}$ | $C_L = 50\text{ pF}$ | 5.0          | 0.4  | 0.8   | V    |
| Quiet output minimum dynamic $V_{OL}$    | $V_{OLV}$ | $C_L = 50\text{ pF}$ | 5.0          | -0.4 | -0.8  | V    |
| Minimum high-level dynamic input voltage | $V_{IHD}$ | $C_L = 50\text{ pF}$ | 5.0          | —    | 3.5   | V    |
| Maximum low-level dynamic input voltage  | $V_{ILD}$ | $C_L = 50\text{ pF}$ | 5.0          | —    | 1.5   | V    |

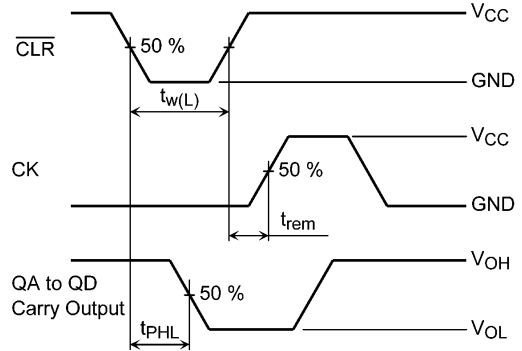
**15. Internal Equivalent Circuit**



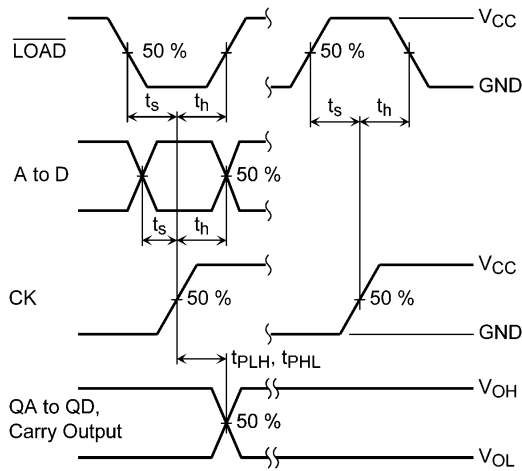
**16. AC Characteristics Test Waveform**



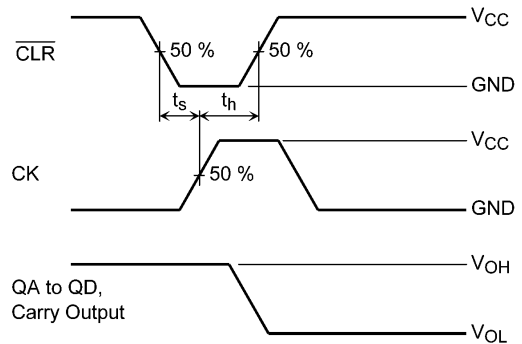
**Figure 1 Count Mode**



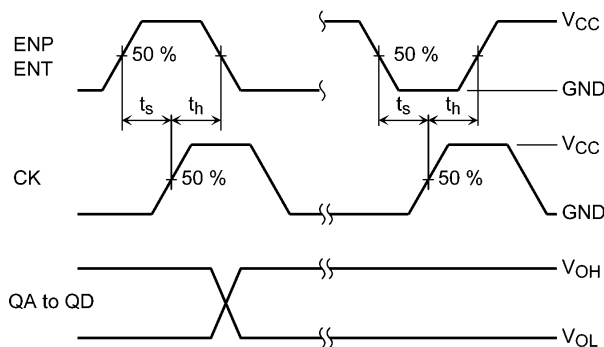
**Figure 4 Clear Mode (74VHC161FT)**



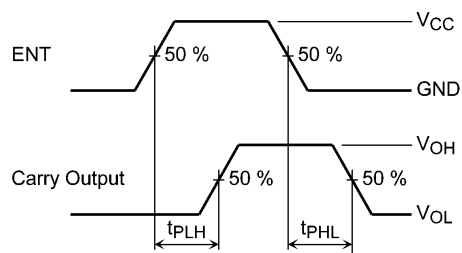
**Figure 2 Preset Mode**



**Figure 5 Clear Mode (74VHC163FT)**

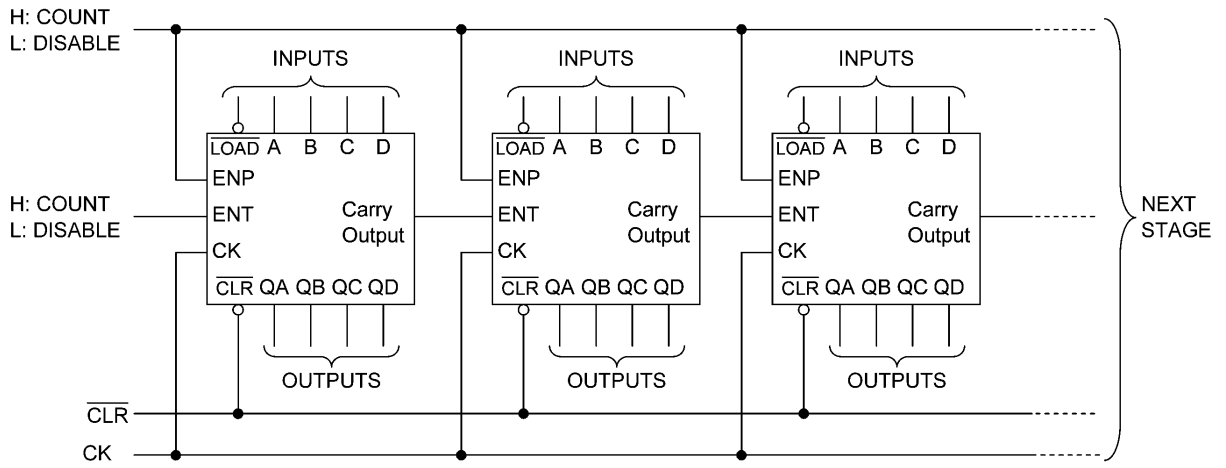


**Figure 3 Count Enable Mode**



**Figure 6 Cascade Mode (fix maximum count)**

**17. Typical Application**

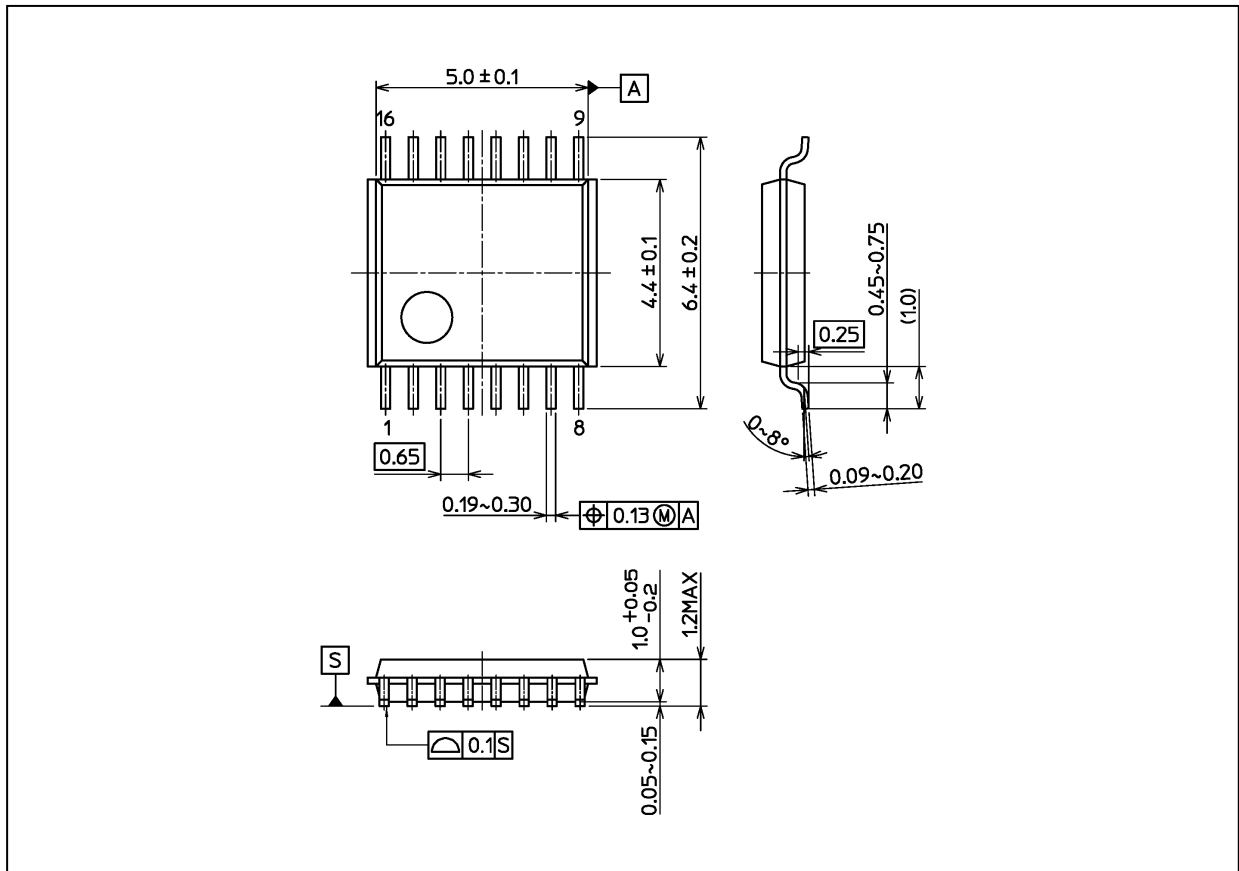


**Parallel Carry N-Bit Counter**



Package Dimensions

Unit: mm



Weight: 0.055 g (typ.)

|                    |
|--------------------|
| Package Name(s)    |
| Nickname: TSSOP16B |

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