



## SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

- HIGH SPEED:  
 $f_{MAX} = 180 \text{ MHz (TYP.) at } V_{CC} = 3.3 \text{ V}$
- COMPATIBLE WITH TTL OUTPUTS
- LOW POWER DISSIPATION:  
 $I_{CC} = 4 \mu\text{A (MAX.) at } T_A = 25^\circ\text{C}$
- LOW NOISE:  
 $V_{OLP} = 0.3\text{V (TYP.) at } V_{CC} = 3.3\text{V}$
- $75\Omega$  TRANSMISSION LINE DRIVING CAPABILITY
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 12\text{mA (MIN) at } V_{CC} = 3.0 \text{ V}$
- PCI BUS LEVELS GUARANTEED AT 24 mA
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \equiv t_{PHL}$
- OPERATING VOLTAGE RANGE:  
 $V_{CC(OPR)} = 2\text{V to } 3.6\text{V (1.2V Data Retention)}$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 163
- IMPROVED LATCH-UP IMMUNITY

### DESCRIPTION

The 74LVQ163 is a low voltage CMOS SYNCHRONOUS PRESETTABLE COUNTER fabricated with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS technology. It is ideal for low power and low noise 3.3V applications. It is a 4 bit binary counter with Synchronous Clear.

The circuit have four fundamental modes of operation, in order of preference: synchronous reset, parallel load, count-up and hold. Four

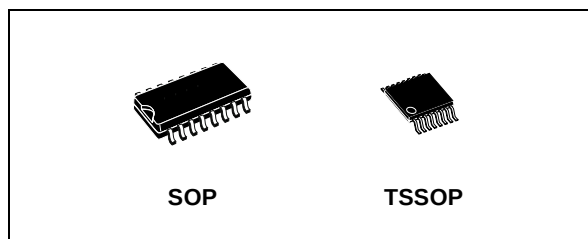


Table 1: Order Codes

| PACKAGE | T & R       |
|---------|-------------|
| SOP     | 74LVQ163MTR |
| TSSOP   | 74LVQ163TTR |

control inputs, Master Reset (CLEAR), Parallel Enable Input (LOAD), Count Enable Input (PE) and Count Enable Carry Input (TE), determine the mode of operation as shown in the Truth Table. A LOW signal on CLEAR overrides counting and parallel loading and allows all outputs to go LOW on the next rising edge of CLOCK. A LOW signal on LOAD overrides counting and allows information on Parallel Data Qn inputs to be loaded into the flip-flops on the next rising edge of CLOCK. With LOAD and CLEAR, PE and TE permit counting when both are high. Conversely, a LOW signal on either PE and TE inhibits counting. All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.

Figure 1: Pin Connection And IEC Logic Symbols

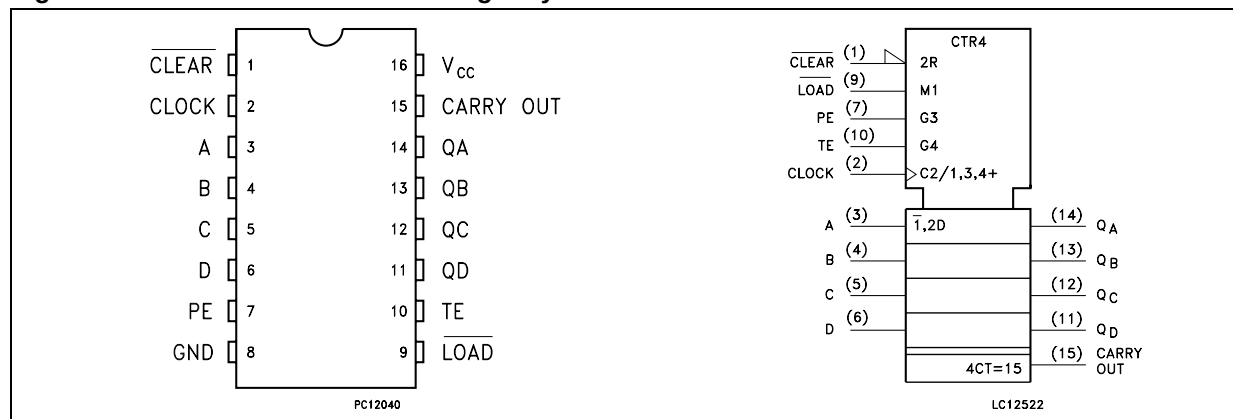


Figure 2: Input And Output Equivalent Circuit

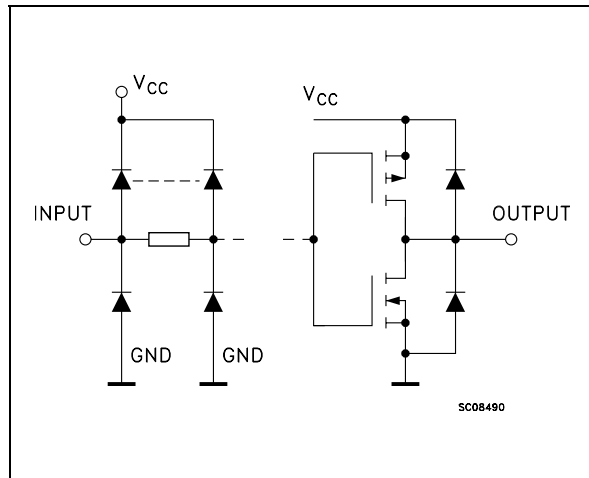


Table 2: Pin Description

| PIN N°         | SYMBOL          | NAME AND FUNCTION                   |
|----------------|-----------------|-------------------------------------|
| 1              | CLEAR           | Synchronous Master Reset            |
| 2              | CLOCK           | Clock Input (Positive Edge Trigger) |
| 3, 4, 5, 6     | A, B, C, D      | Data Inputs                         |
| 7              | PE              | Count Enable Input                  |
| 10             | TE              | Count Enable Carry Input            |
| 9              | LOAD            | Parallel Enable Input               |
| 14, 13, 12, 11 | QA to QD        | Flip-Flop Outputs                   |
| 15             | CARRY OUT       | Terminal Count Output               |
| 8              | GND             | Ground (0V)                         |
| 16             | V <sub>CC</sub> | Positive Supply Voltage             |

Table 3: Truth Table

| INPUTS |      |    |    |    | OUTPUTS   |   |   |   | FUNCTION     |
|--------|------|----|----|----|-----------|---|---|---|--------------|
| CLEAR  | LOAD | PE | TE | CK |           |   |   |   |              |
| L      | X    | X  | X  |    | L         | L | L | L | RESET TO "0" |
| H      | L    | X  | X  |    | A         | B | C | D | 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        |
| H      | X    | X  | X  |    | NO CHANGE |   |   |   | NO COUNT     |

X : Don't Care; A, B, C, D; Logic level of data input; CARRY OUT : TE x QA x QB x QC x QD

Figure 3: Logic Diagram

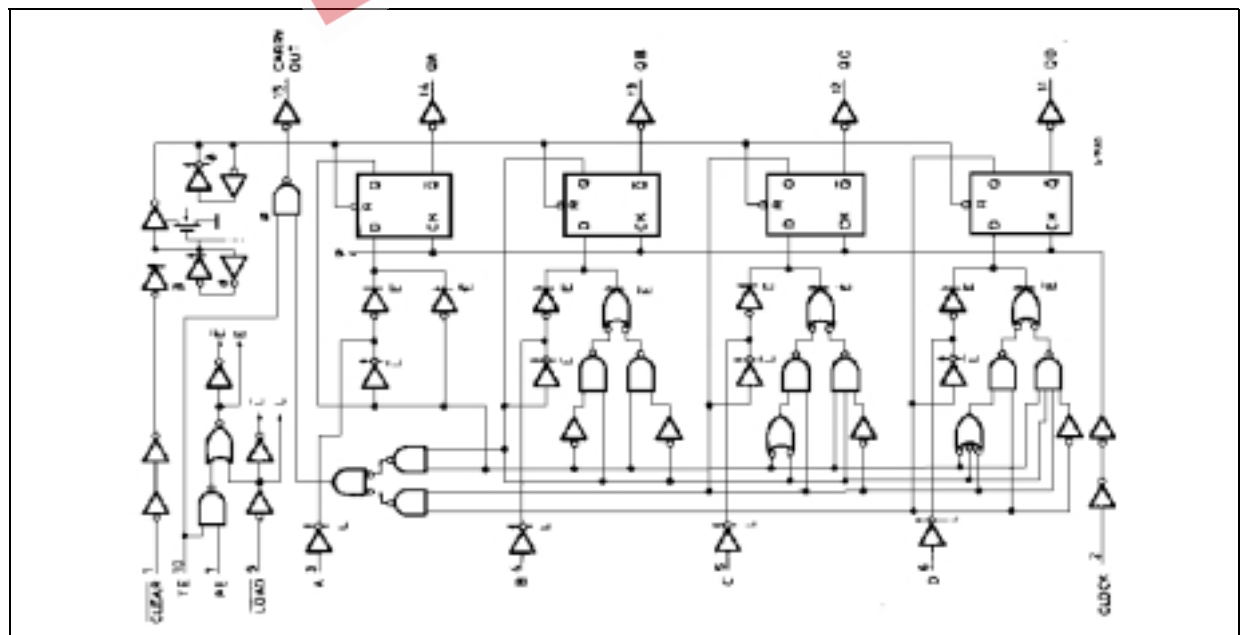


Figure 4: Timing Chart

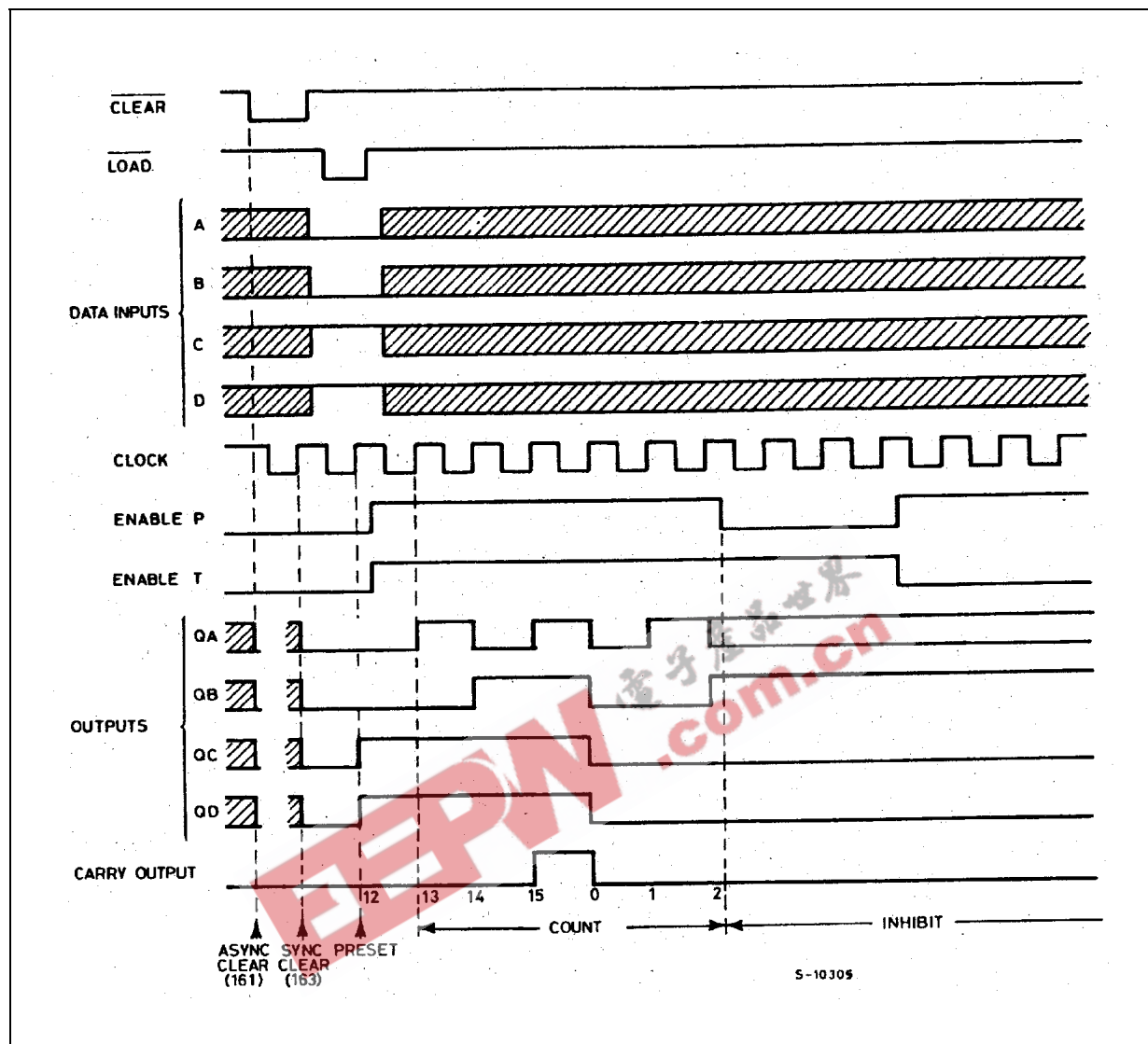


Table 4: Absolute Maximum Ratings

| Symbol                | Parameter                     | Value                  | Unit |
|-----------------------|-------------------------------|------------------------|------|
| $V_{CC}$              | Supply Voltage                | -0.5 to +7             | V    |
| $V_I$                 | DC Input Voltage              | -0.5 to $V_{CC} + 0.5$ | V    |
| $V_O$                 | DC Output Voltage             | -0.5 to $V_{CC} + 0.5$ | V    |
| $I_{IK}$              | DC Input Diode Current        | $\pm 20$               | mA   |
| $I_{OK}$              | DC Output Diode Current       | $\pm 20$               | mA   |
| $I_O$                 | DC Output Current             | $\pm 50$               | mA   |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | $\pm 300$              | mA   |
| $T_{stg}$             | Storage Temperature           | -65 to +150            | °C   |
| $T_L$                 | Lead Temperature (10 sec)     | 300                    | °C   |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

Table 5: Recommended Operating Conditions

| Symbol   | Parameter                                         | Value         | Unit |
|----------|---------------------------------------------------|---------------|------|
| $V_{CC}$ | Supply Voltage (note 1)                           | 2 to 3.6      | V    |
| $V_I$    | Input Voltage                                     | 0 to $V_{CC}$ | V    |
| $V_O$    | Output Voltage                                    | 0 to $V_{CC}$ | V    |
| $T_{op}$ | Operating Temperature                             | -55 to 125    | °C   |
| dt/dv    | Input Rise and Fall Time $V_{CC} = 3.0V$ (note 2) | 0 to 10       | ns/V |

1) Truth Table guaranteed: 1.2V to 3.6V

2)  $V_{IN}$  from 0.8V to 2V

Table 6: DC Specifications

| Symbol           | Parameter                          | Test Condition         |                                         | Value                 |       |       |             |      |              |      |    | Unit |
|------------------|------------------------------------|------------------------|-----------------------------------------|-----------------------|-------|-------|-------------|------|--------------|------|----|------|
|                  |                                    | V <sub>CC</sub><br>(V) |                                         | T <sub>A</sub> = 25°C |       |       | -40 to 85°C |      | -55 to 125°C |      |    |      |
|                  |                                    |                        |                                         | Min.                  | Typ.  | Max.  | Min.        | Max. | Min.         | Max. |    |      |
| V <sub>IH</sub>  | High Level Input Voltage           | 3.0 to 3.6             |                                         | 2.0                   |       |       | 2.0         |      | 2.0          |      | V  |      |
| V <sub>IL</sub>  | Low Level Input Voltage            |                        |                                         |                       |       | 0.8   |             | 0.8  |              | 0.8  | V  |      |
| V <sub>OH</sub>  | High Level Output Voltage          | 3.0                    | I <sub>O</sub> =50 μA                   | 2.9                   | 2.99  |       | 2.9         |      | 2.9          |      | V  |      |
|                  |                                    |                        | I <sub>O</sub> =12 mA                   | 2.58                  |       |       | 2.48        |      | 2.48         |      |    |      |
|                  |                                    |                        | I <sub>O</sub> =24 mA                   |                       |       |       | 2.2         |      | 2.2          |      |    |      |
| V <sub>OL</sub>  | Low Level Output Voltage           | 3.0                    | I <sub>O</sub> =50 μA                   |                       | 0.002 | 0.1   |             | 0.1  |              | 0.1  | V  |      |
|                  |                                    |                        | I <sub>O</sub> =12 mA                   |                       | 0     | 0.36  |             | 0.44 |              | 0.44 |    |      |
|                  |                                    |                        | I <sub>O</sub> =24 mA                   |                       |       |       |             | 0.55 |              | 0.55 |    |      |
| I <sub>I</sub>   | Input Leakage Current              | 3.6                    | V <sub>I</sub> = V <sub>CC</sub> or GND |                       |       | ± 0.1 |             | ± 1  |              | ± 1  | μA |      |
| I <sub>CC</sub>  | Quiescent Supply Current           | 3.6                    | V <sub>I</sub> = V <sub>CC</sub> or GND |                       |       | 4     |             | 40   |              | 40   | μA |      |
| I <sub>OLD</sub> | Dynamic Output Current (note 1, 2) | 3.6                    | V <sub>OLD</sub> = 0.8 V max            |                       |       |       | 36          |      | 25           |      | mA |      |
| I <sub>OHD</sub> |                                    |                        | V <sub>OHD</sub> = 2 V min              |                       |       |       | -25         |      | -25          |      | mA |      |

1) Maximum test duration 2ms, one output loaded at time

2) Incident wave switching is guaranteed on transmission lines with impedances as low as 75Ω

Table 7: Dynamic Switching Characteristics

| Symbol           | Parameter                                    | Test Condition         |                        | Value                 |      |      |             |      |              | Unit |      |
|------------------|----------------------------------------------|------------------------|------------------------|-----------------------|------|------|-------------|------|--------------|------|------|
|                  |                                              | V <sub>CC</sub><br>(V) |                        | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                  |                                              |                        |                        | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| V <sub>OLP</sub> | Dynamic Low Voltage Quiet Output (note 1, 2) | 3.3                    | C <sub>L</sub> = 50 pF |                       | 0.3  | 0.8  |             |      |              |      | V    |
| V <sub>OLV</sub> |                                              |                        |                        | -0.8                  | -0.3 |      |             |      |              |      |      |
| V <sub>IHD</sub> | Dynamic High Voltage Input (note 1, 3)       | 3.3                    |                        | 2                     |      |      |             |      |              |      | V    |
| V <sub>ILD</sub> | Dynamic Low Voltage Input (note 1, 3)        | 3.3                    |                        |                       |      |      | 0.8         |      |              |      |      |

1) Worst case package.

2) Max number of outputs defined as (n). Data inputs are driven 0V to 3.3V, (n-1) outputs switching and one output at GND.

3) Max number of data inputs (n) switching. (n-1) switching 0V to 3.3V. Inputs under test switching: 3.3V to threshold ( $V_{ILD}$ ), 0V to threshold ( $V_{IHD}$ ),  $f=1\text{MHz}$ .

Table 8: AC Electrical Characteristics ( $C_L = 50 \text{ pF}$ ,  $R_L = 500 \Omega$ , Input  $t_r = t_f = 3 \text{ ns}$ )

| Symbol                                 | Parameter                                  | Test Condition         |  | Value                 |      |      |             |      |              | Unit |      |
|----------------------------------------|--------------------------------------------|------------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|
|                                        |                                            | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                                        |                                            |                        |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time CK to Q             | 2.7                    |  |                       | 7.5  | 12.0 |             | 15.0 |              | 17.0 | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  |                       | 6.3  | 9.5  |             | 11.0 |              | 12.5 |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time CK to CARRY OUT     | 2.7                    |  |                       | 8.8  | 14.0 |             | 16.0 |              | 18.5 | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  |                       | 7.1  | 10.5 |             | 12.0 |              | 14.0 |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time TE to CARRY OUT     | 2.7                    |  |                       | 6.1  | 10.0 |             | 11.5 |              | 13.0 | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  |                       | 5.2  | 8.0  |             | 9.5  |              | 10.5 |      |
| t <sub>W</sub>                         | CK pulse Width, (Count) High or LOW        | 2.7                    |  | 4.0                   | 1.9  |      | 4.0         |      | 4.0          |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 3.0                   | 1.9  |      | 3.0         |      | 3.0          |      |      |
| t <sub>W</sub>                         | CK pulse Width, (Load) High or LOW         | 2.7                    |  | 4.0                   | 1.9  |      | 4.0         |      | 4.0          |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 3.0                   | 1.9  |      | 3.0         |      | 3.0          |      |      |
| t <sub>s</sub>                         | Setup Time HIGH or LOW (INPUT to CLOCK)    | 2.7                    |  | 5.0                   | 2.5  |      | 5.0         |      | 5.0          |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 4.0                   | 2.1  |      | 4.0         |      | 4.0          |      |      |
| t <sub>h</sub>                         | Hold Time HIGH or LOW (INPUT to CLOCK)     | 2.7                    |  | 1                     | -1.6 |      | 1           |      | 1            |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 0.5                   | -1.2 |      | 0.5         |      | 0.5          |      |      |
| t <sub>s</sub>                         | Setup Time HIGH or LOW (CLEAR to CLOCK)    | 2.7                    |  | 3.0                   | 1.5  |      | 3.0         |      | 3.0          |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 2.5                   | 1.2  |      | 2.5         |      | 2.5          |      |      |
| t <sub>h</sub>                         | Hold Time HIGH or LOW (CLEAR to CLOCK)     | 2.7                    |  | 1                     | -0.6 |      | 1           |      | 1            |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 0.5                   | -0.5 |      | 0.5         |      | 0.5          |      |      |
| t <sub>s</sub>                         | Setup Time HIGH or LOW (LOAD to CLOCK)     | 2.7                    |  | 8.0                   | 3.7  |      | 8.0         |      | 8.0          |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 6.0                   | 3.2  |      | 6.0         |      | 6.0          |      |      |
| t <sub>h</sub>                         | Hold Time HIGH or LOW (LOAD to CLOCK)      | 2.7                    |  | 0                     | -3.0 |      | 0           |      | 0            |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 0                     | -2.5 |      | 0           |      | 0            |      |      |
| t <sub>s</sub>                         | Setup Time HIGH or LOW (PE or TE to CLOCK) | 2.7                    |  | 7.0                   | 3.4  |      | 7.0         |      | 7.0          |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 6.0                   | 3.0  |      | 6.0         |      | 6.0          |      |      |
| t <sub>h</sub>                         | Hold Time HIGH or LOW (PE or TE to CLOCK)  | 2.7                    |  | 0                     | -2.6 |      | 0           |      | 0            |      | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 0                     | -2.2 |      | 0           |      | 0            |      |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency                    | 2.7                    |  | 100                   | 150  |      | 80          |      | 60           |      | MHz  |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  | 120                   | 180  |      | 100         |      | 80           |      |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | Output To Output Skew Time (note1, 2)      | 2.7                    |  |                       | 0.5  | 1.0  |             | 1.0  |              | 1.0  | ns   |
|                                        |                                            | 3.3 <sup>(*)</sup>     |  |                       | 0.5  | 1.0  |             | 1.0  |              | 1.0  |      |

1) Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW ( $t_{OSLH} = |t_{PLHm} - t_{PLHn}|$ ,  $t_{OSHL} = |t_{PHLm} - t_{PHLn}|$ )

2) Parameter guaranteed by design

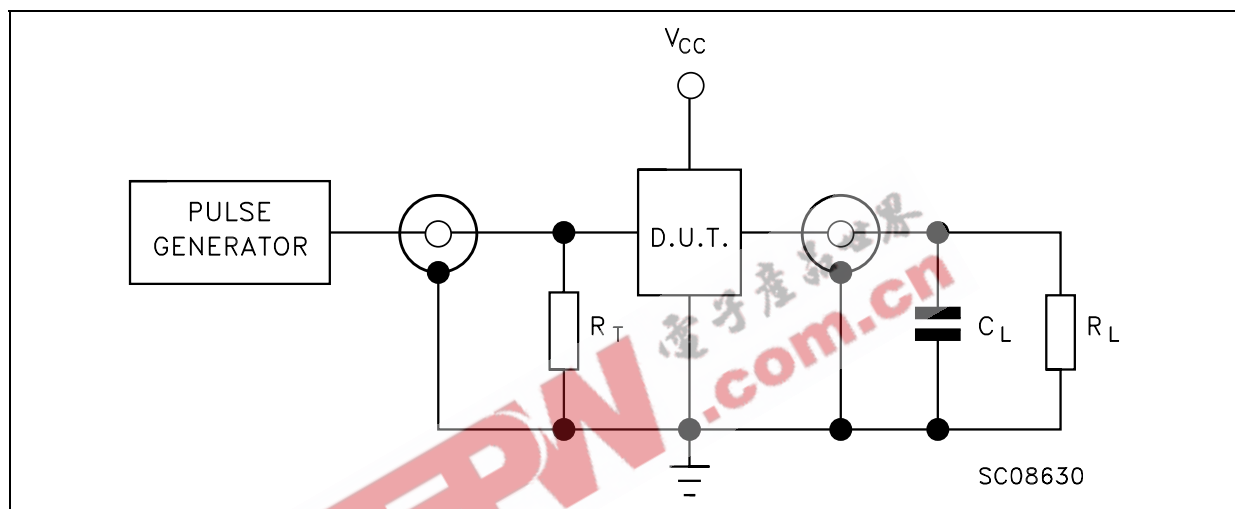
(\*) Voltage range is  $3.3V \pm 0.3V$

Table 9: Capacitive Characteristics

| Symbol          | Parameter                              | Test Condition         |                         | Value                 |      |      |             |      |              | Unit |      |
|-----------------|----------------------------------------|------------------------|-------------------------|-----------------------|------|------|-------------|------|--------------|------|------|
|                 |                                        | V <sub>CC</sub><br>(V) |                         | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                 |                                        |                        |                         | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| C <sub>IN</sub> | Input Capacitance                      | 3.3                    |                         |                       | 4    |      |             |      |              |      | pF   |
| C <sub>PD</sub> | Power Dissipation Capacitance (note 1) | 3.3                    | f <sub>IN</sub> = 10MHz |                       | 33   |      |             |      |              |      | pF   |

1) C<sub>PD</sub> is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/n$  (per circuit)

Figure 5: Test Circuit



C<sub>L</sub> = 50pF or equivalent (includes jig and probe capacitance)  
R<sub>L</sub> = 500Ω or equivalent  
R<sub>T</sub> = Z<sub>OUT</sub> of pulse generator (typically 50Ω)

Figure 6: Waveform - Propagation Delays, Count Mode (f=1MHz; 50% duty cycle)

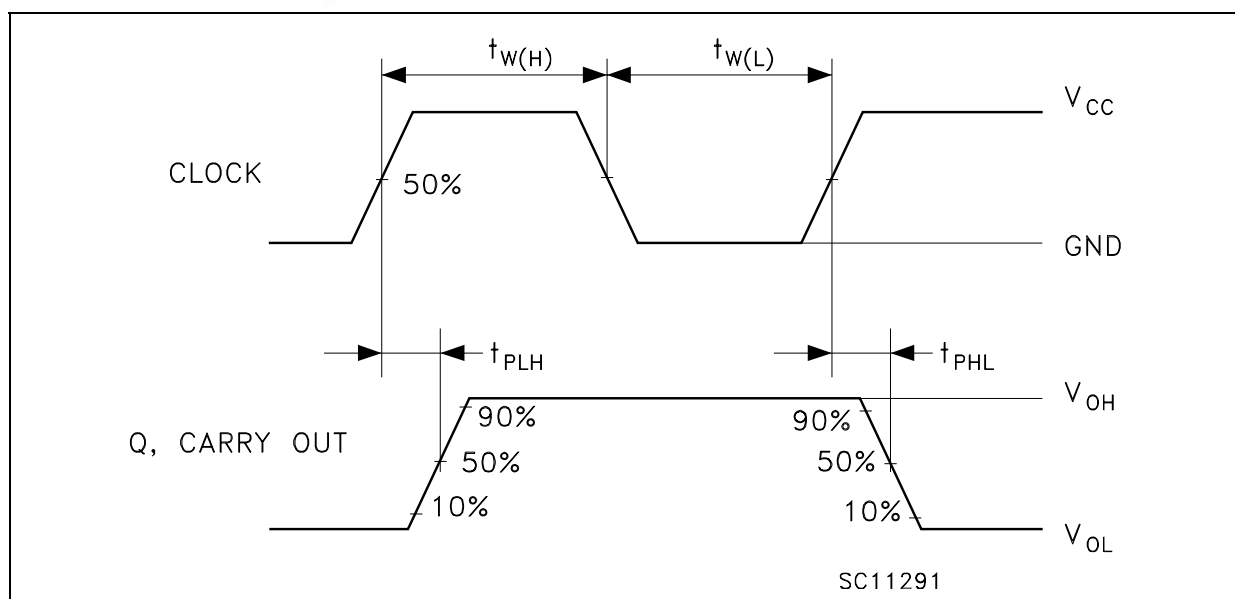


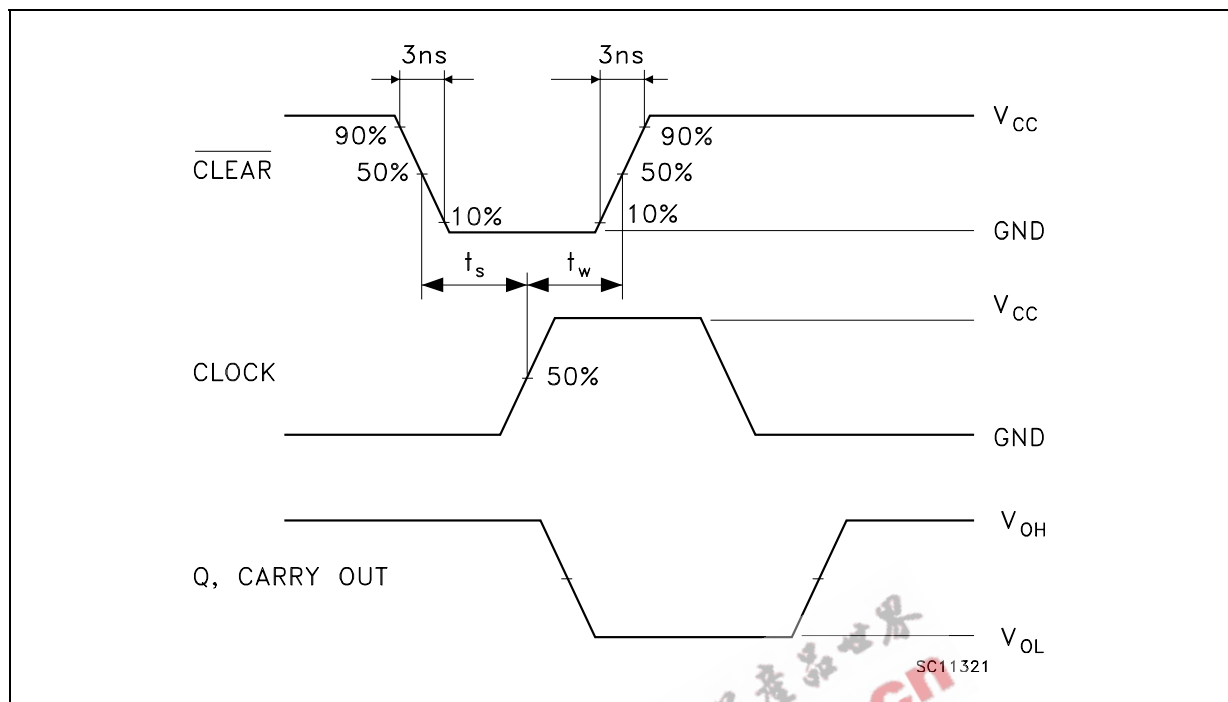
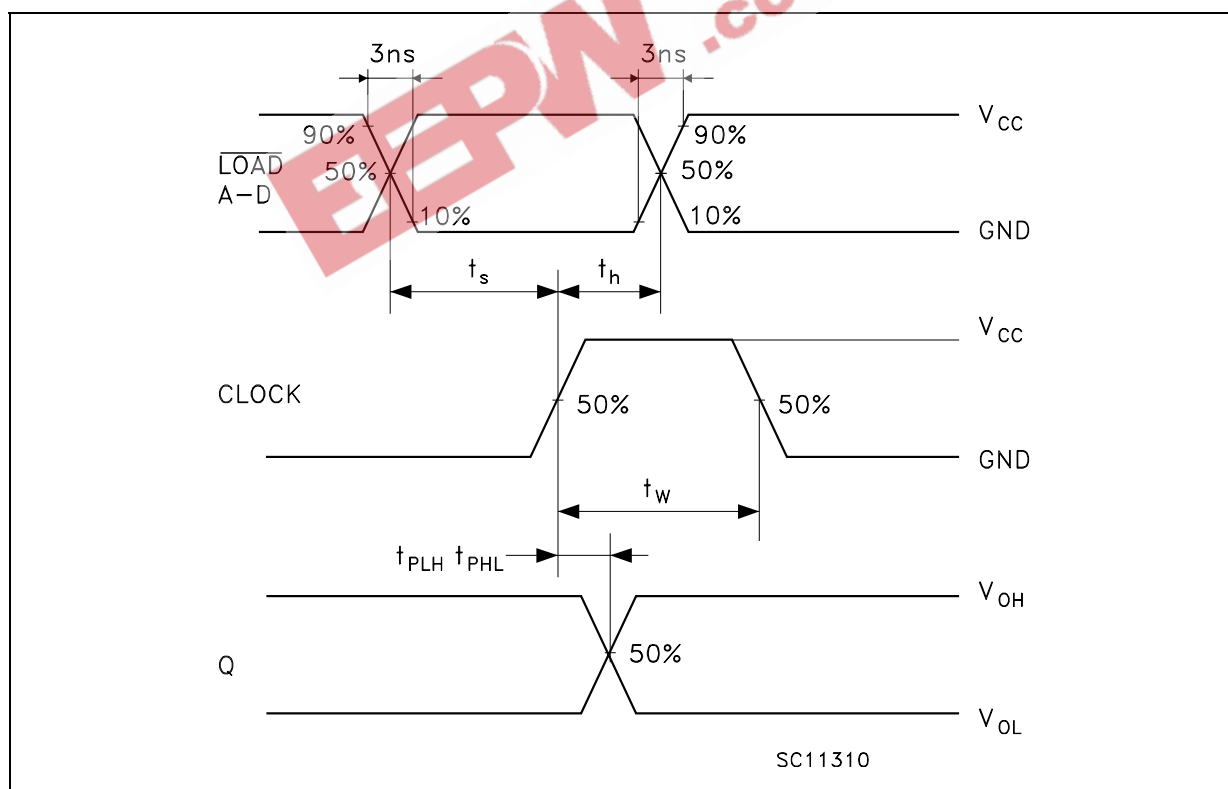
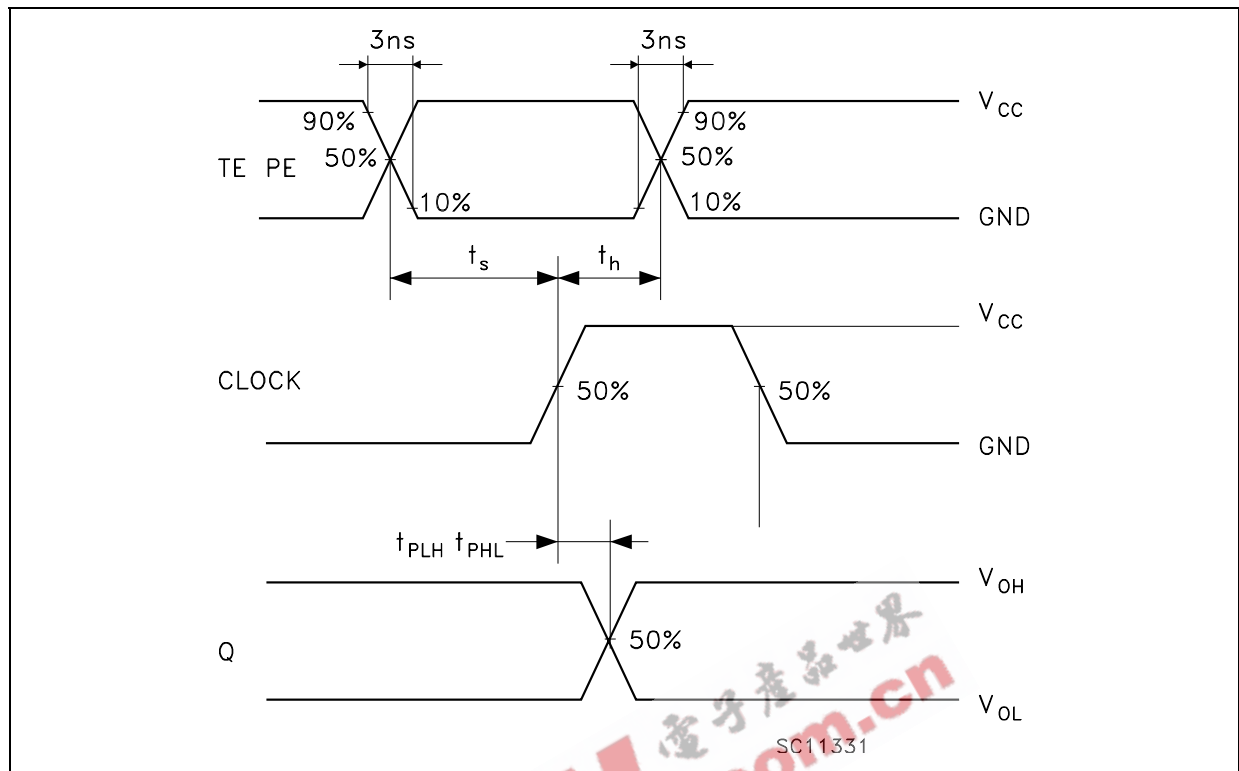
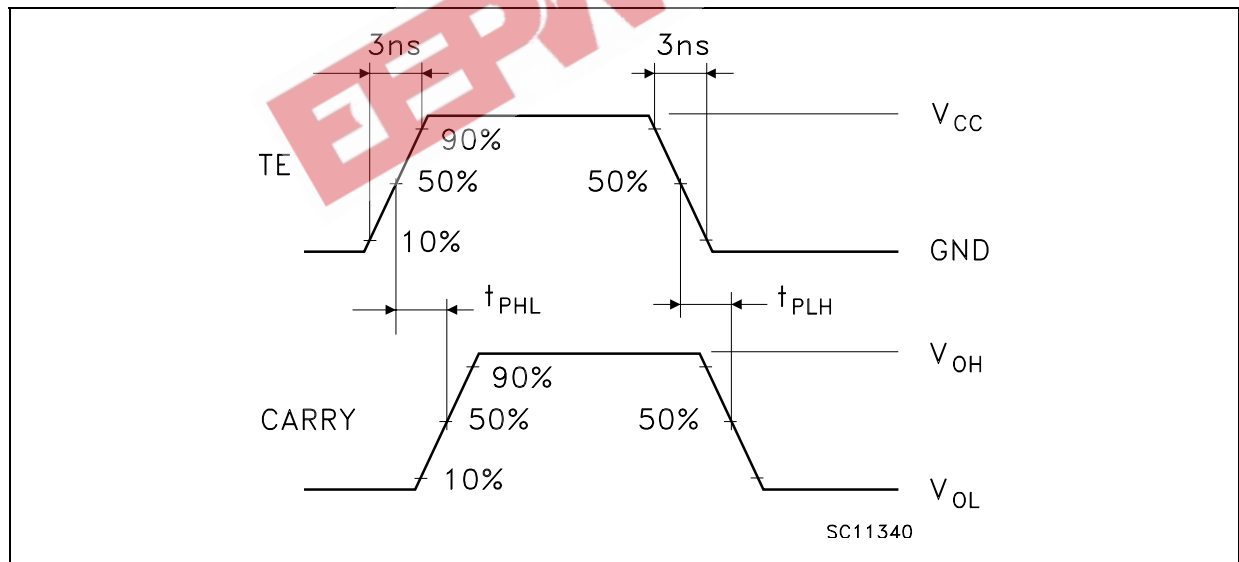
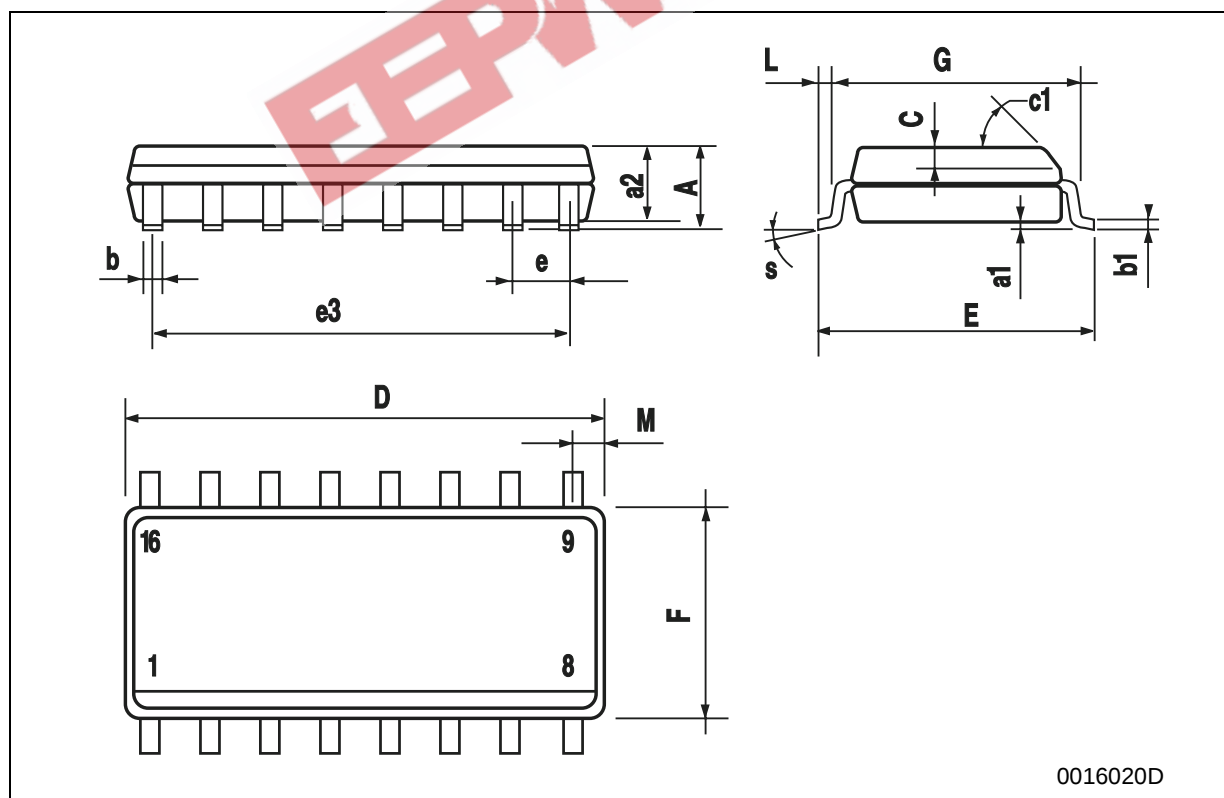
Figure 7: Waveform - Propagation Delays Clear Mode ( $f=1\text{MHz}$ ; 50% duty cycle)Figure 8: Waveform - Propagation Delays Preset Mode ( $f=1\text{MHz}$ ; 50% duty cycle)

Figure 9: Waveform - Propagation Delays Countable Mode ( $f=1\text{MHz}$ ; 50% duty cycle)Figure 10: Waveform - Propagation Delays Cascade Mode ( $f=1\text{MHz}$ ; 50% duty cycle)

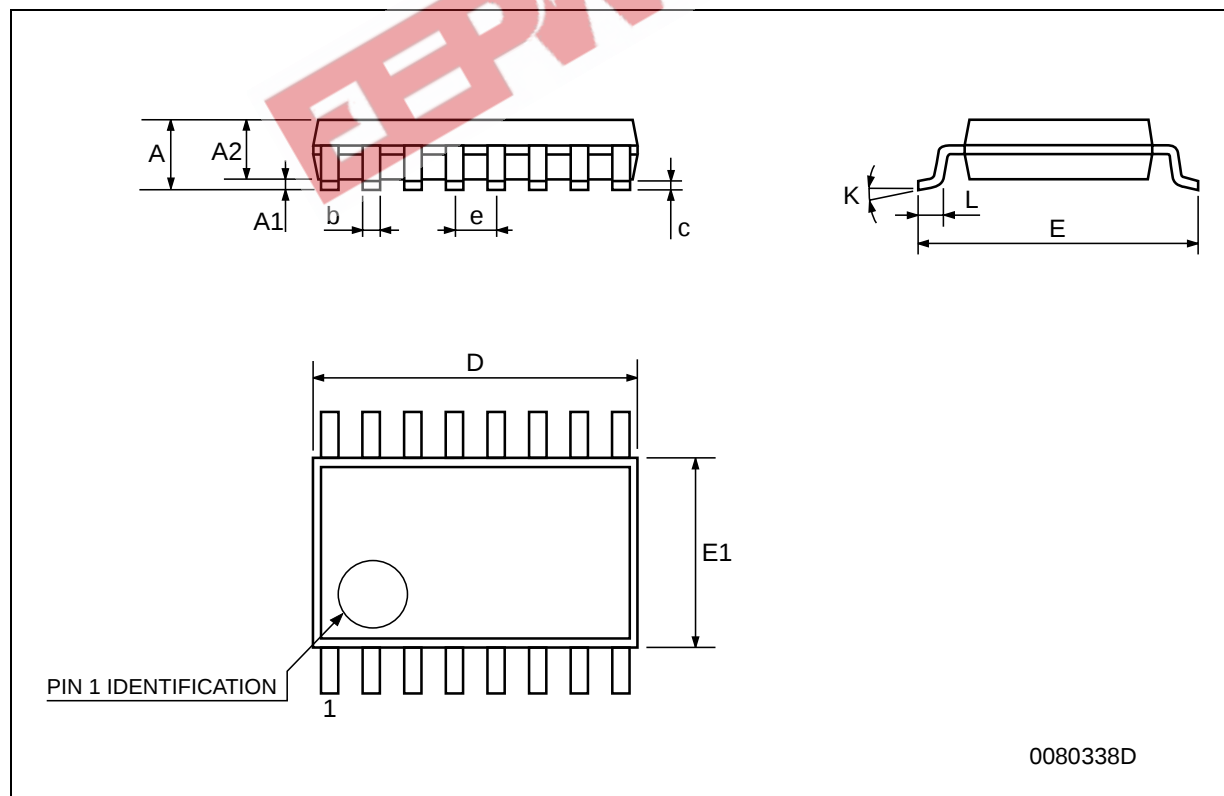
## SO-16 MECHANICAL DATA

| DIM. | mm.        |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.25 | 0.004 |       | 0.010 |
| a2   |            |      | 1.64 |       |       | 0.063 |
| b    | 0.35       |      | 0.46 | 0.013 |       | 0.018 |
| b1   | 0.19       |      | 0.25 | 0.007 |       | 0.010 |
| C    |            | 0.5  |      |       | 0.019 |       |
| c1   | 45° (typ.) |      |      |       |       |       |
| D    | 9.8        |      | 10   | 0.385 |       | 0.393 |
| E    | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e    |            | 1.27 |      |       | 0.050 |       |
| e3   |            | 8.89 |      |       | 0.350 |       |
| F    | 3.8        |      | 4.0  | 0.149 |       | 0.157 |
| G    | 4.6        |      | 5.3  | 0.181 |       | 0.208 |
| L    | 0.5        |      | 1.27 | 0.019 |       | 0.050 |
| M    |            |      | 0.62 |       |       | 0.024 |
| S    | 8° (max.)  |      |      |       |       |       |



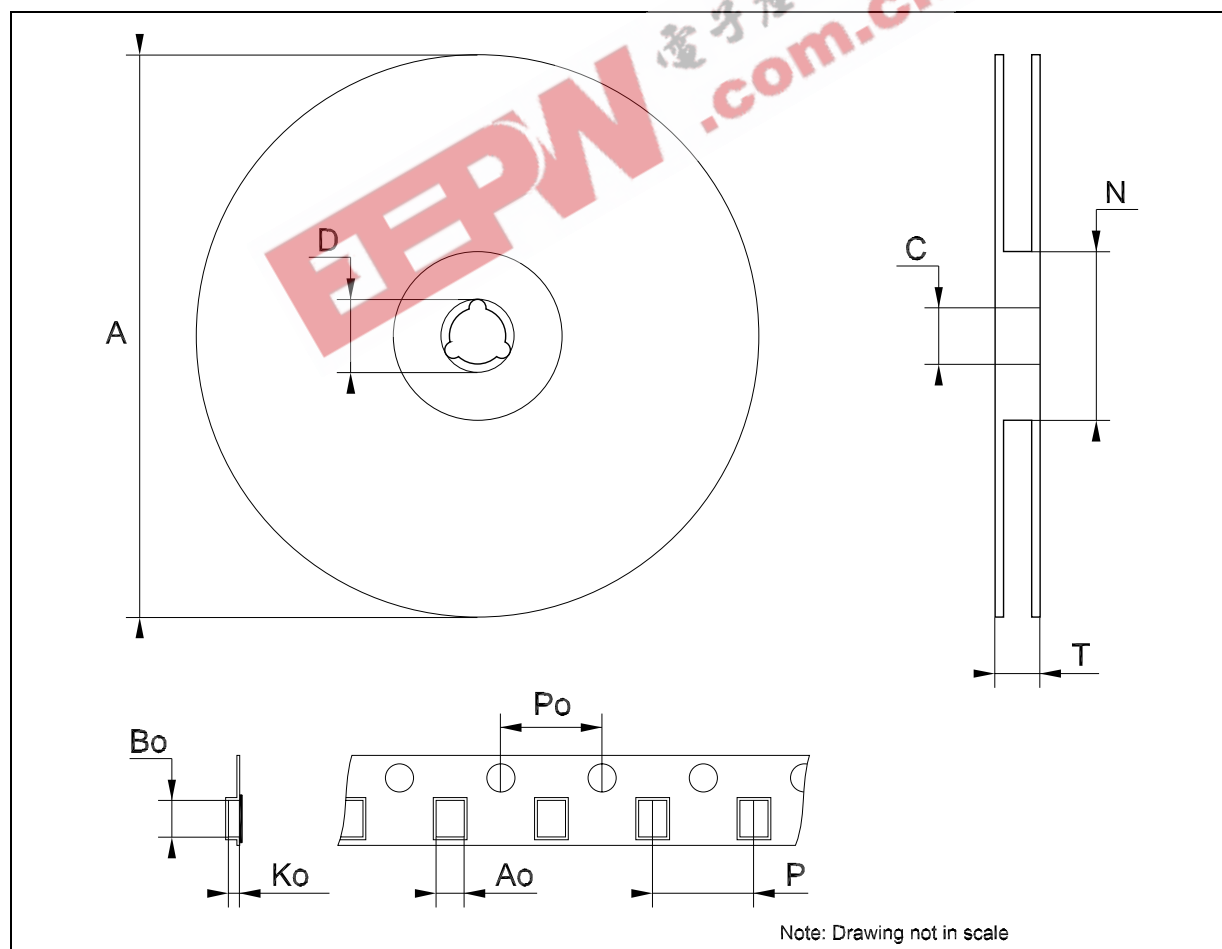
## TSSOP16 MECHANICAL DATA

| DIM. | mm.  |          |      | inch  |            |        |
|------|------|----------|------|-------|------------|--------|
|      | MIN. | TYP      | MAX. | MIN.  | TYP.       | MAX.   |
| A    |      |          | 1.2  |       |            | 0.047  |
| A1   | 0.05 |          | 0.15 | 0.002 | 0.004      | 0.006  |
| A2   | 0.8  | 1        | 1.05 | 0.031 | 0.039      | 0.041  |
| b    | 0.19 |          | 0.30 | 0.007 |            | 0.012  |
| c    | 0.09 |          | 0.20 | 0.004 |            | 0.0079 |
| D    | 4.9  | 5        | 5.1  | 0.193 | 0.197      | 0.201  |
| E    | 6.2  | 6.4      | 6.6  | 0.244 | 0.252      | 0.260  |
| E1   | 4.3  | 4.4      | 4.48 | 0.169 | 0.173      | 0.176  |
| e    |      | 0.65 BSC |      |       | 0.0256 BSC |        |
| K    | 0°   |          | 8°   | 0°    |            | 8°     |
| L    | 0.45 | 0.60     | 0.75 | 0.018 | 0.024      | 0.030  |



## Tape &amp; Reel SO-16 MECHANICAL DATA

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 22.4 |       |      | 0.882  |
| Ao   | 6.45 |     | 6.65 | 0.254 |      | 0.262  |
| Bo   | 10.3 |     | 10.5 | 0.406 |      | 0.414  |
| Ko   | 2.1  |     | 2.3  | 0.082 |      | 0.090  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 7.9  |     | 8.1  | 0.311 |      | 0.319  |



## Tape &amp; Reel TSSOP16 MECHANICAL DATA

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 22.4 |       |      | 0.882  |
| Ao   | 6.7  |     | 6.9  | 0.264 |      | 0.272  |
| Bo   | 5.3  |     | 5.5  | 0.209 |      | 0.217  |
| Ko   | 1.6  |     | 1.8  | 0.063 |      | 0.071  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 7.9  |     | 8.1  | 0.311 |      | 0.319  |

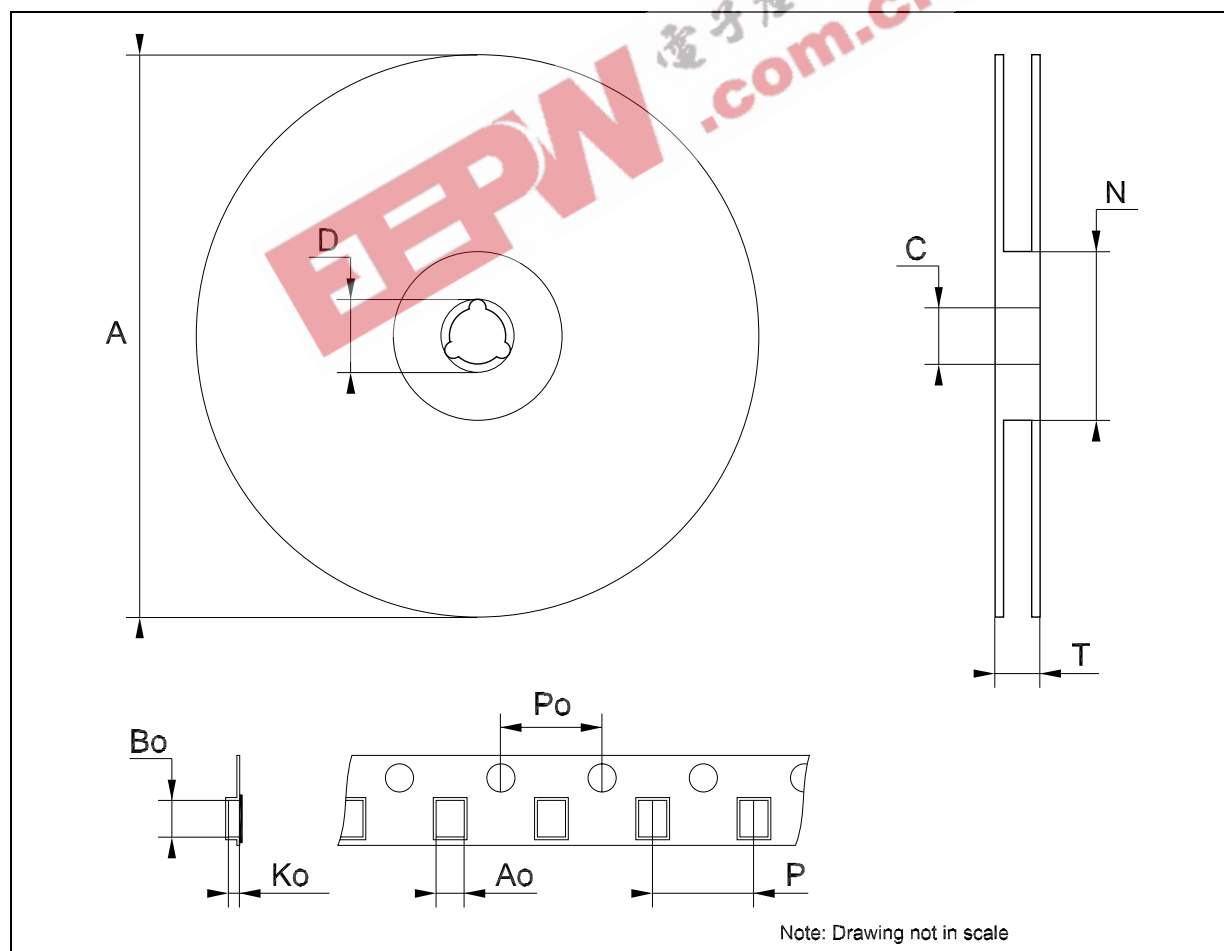


Table 10: Revision History

| Date        | Revision | Description of Changes            |
|-------------|----------|-----------------------------------|
| 29-Jul-2004 | 2        | Ordering Codes Revision - pag. 1. |

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