

Dual 4-input NAND gate

Features

- High speed: $t_{PD} = 3.3$ ns (typ.) at $V_{CC} = 5$ V
- Low power dissipation:
 $I_{CC} = 2 \mu A$ (max.) at $T_A = 25^\circ C$
- High noise immunity:
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min.)
- Power-down protection on inputs
- Symmetrical output impedance:
 $|I_{OHL}| = |I_{OL}| = 8$ mA (min)
- Balanced propagation delays: $t_{PLH} \approx t_{PHL}$
- Operating voltage range:
 V_{CC} (OPR) = 2 V to 5.5 V
- Pin and function compatible with 74 series 20
- Improved latch-up immunity

**Description**

The 74VHC20 is an advanced high-speed CMOS dual 4-input NAND gate, manufactured with sub-micron silicon gate and double-layer metal wiring C²MOS technology.

The internal circuit is composed of three stages including a buffer output, which provides high noise immunity and stable output.

Power-down protection is provided on all inputs and 0 to 7 V can be accepted on the inputs with no regard to the supply voltage. This device can be used to interface 5 V to 3 V.

All inputs and outputs are equipped with protection circuits against static discharge, giving them 2 kV ESD immunity and transient excess voltage.

1 Pin connections

Figure 1. Pin connections and IEC logic symbols

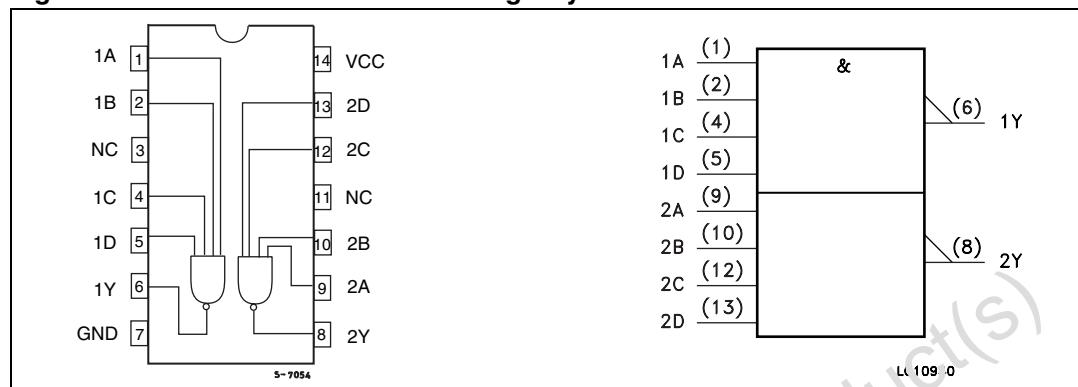
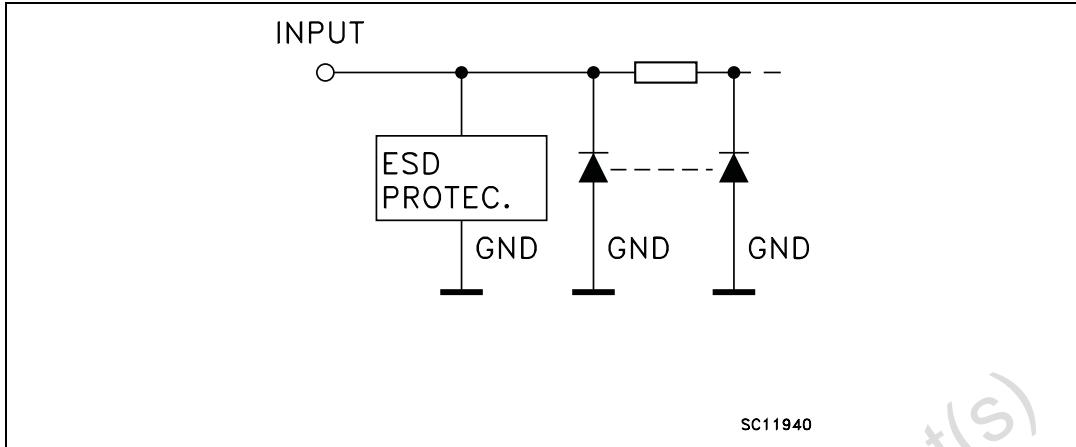


Table 1. Pin descriptions

| Pin number | Symbol | Name and function |
|------------|-----------------|-------------------------|
| 1, 9 | 1A to 2A | Data inputs |
| 2, 10 | 1B to 2B | Data inputs |
| 3, 11 | N.C. | Not connected |
| 4, 12 | 1C to 2C | Data inputs |
| 5, 13 | 1D to 2D | Data inputs |
| 6, 8 | 1Y to 2Y | Data outputs |
| 7 | GND | Ground (0 V) |
| 14 | V _{CC} | Positive supply voltage |

Table 2. Truth table

| A | B | C | D | Y |
|---|---|---|---|---|
| L | X | X | X | H |
| X | L | X | X | H |
| X | X | L | X | H |
| X | X | X | L | H |
| H | H | H | H | L |

Figure 2. Input equivalent circuit

2 Absolute maximum ratings and operating conditions

Note: *Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.*

Table 3. Absolute maximum ratings (AMR)

| Symbol | Parameter | Value | Unit |
|-----------------------|-------------------------------|------------------------|------|
| V_{CC} | Supply voltage | -0.5 to +7.0 | V |
| V_I | DC input voltage | -0.5 to +7.0 | V |
| V_O | DC output voltage | -0.5 to $V_{CC} + 0.5$ | V |
| I_{IK} | DC input diode current | - 20 | mA |
| I_{OK} | DC output diode current | ± 20 | mA |
| I_O | DC output current | ± 25 | mA |
| I_{CC} or I_{GND} | DC V_{CC} or ground current | ± 50 | mA |
| T_{stg} | Storage temperature | -65 to +150 | °C |
| T_L | Lead temperature (10 sec) | 300 | °C |

Table 4. Recommended operating conditions

| Symbol | Parameter | Value | Unit |
|----------|---|---------------------|------|
| V_{CC} | Supply voltage | 2 to 5.5 | V |
| V_I | Input voltage | 0 to 5.5 | V |
| V_O | Output voltage | 0 to V_{CC} | V |
| T_{op} | Operating temperature | -55 to 125 | °C |
| dI/dV | Input rise and fall time ⁽¹⁾ $V_{CC} = 3.3 \pm 0.3$ V $V_{CC} = 5.0 \pm 0.5$ V | 0 to 100 0 to 20 | ns/V |

⁽¹⁾ V_{IN} from 30% to 70% of V_{CC} .

3 Electrical characteristics

Table 5. DC specifications

| Symbol | Parameter | Test conditions | | Value | | | | | | Unit | |
|----------|---------------------------|-----------------|-------------------------------|--------------------|--------------------|-----------|------------------------------|---------|-------------------------------|---------|---------|
| | | V_{CC} (V) | | $T_A = 25^\circ C$ | | | $-40 \text{ to } 85^\circ C$ | | $-55 \text{ to } 125^\circ C$ | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| V_{IH} | High level input voltage | 2.0 | | 1.5 | | | 1.5 | | 1.5 | | V |
| | | 3.0 to 5.5 | | 0.7V _{CC} | | | 0.7V _{CC} | | 0.7V _{CC} | | |
| V_{IL} | Low level input voltage | 2.0 | | | 0.5 | | 0.5 | | 0.5 | | V |
| | | 3.0 to 5.5 | | | 0.3V _{CC} | | 0.3V _{CC} | | 0.3V _{CC} | | |
| V_{OH} | High level output voltage | 2.0 | $I_O = -50 \mu A$ | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 3.0 | $I_O = -50 \mu A$ | 2.9 | 3.0 | | 2.9 | | 2.9 | | |
| | | 4.5 | $I_O = -50 \mu A$ | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 3.0 | $I_O = -4 mA$ | 2.58 | | | 2.48 | | 2.4 | | |
| | | 4.5 | $I_O = -8 mA$ | 3.94 | | | 3.8 | | 3.7 | | |
| V_{OL} | Low level output voltage | 2.0 | $I_O = 50 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 3.0 | $I_O = 50 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 | $I_O = 50 \mu A$ | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 3.0 | $I_O = 4 mA$ | | | 0.36 | | 0.44 | | 0.55 | |
| | | 4.5 | $I_O = 8 mA$ | | | 0.36 | | 0.44 | | 0.55 | |
| I_I | Input leakage current | 0 to 5.5 | $V_I = 5.5 V \text{ or GND}$ | | | ± 0.1 | | ± 1 | | ± 1 | μA |
| I_{CC} | Quiescent supply current | 5.5 | $V_I = V_{CC} \text{ or GND}$ | | | 2 | | 20 | | 20 | μA |

Table 6. AC electrical characteristics (input $t_r = t_f = 3$ ns)

| Symbol | Parameter | Test conditions | | | Value | | | | | | Unit | |
|------------------------|------------------------|--------------------|---------------|--|--------------------------|------|------|------------------------------------|------|-------------------------------------|------|--|
| | | V_{CC} (V) | C_L (pF) | | $T_A = 25^\circ\text{C}$ | | | $-40 \text{ to } 85^\circ\text{C}$ | | $-55 \text{ to } 125^\circ\text{C}$ | | |
| | | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | |
| t_{PLH} t_{PHL} | Propagation delay time | 3.3 ⁽¹⁾ | 15 | | | 4.6 | 6.6 | 1.0 | 8.0 | 1.0 | 8.0 | |
| | | 3.3 ⁽¹⁾ | 50 | | | 7.1 | 10.1 | 1.0 | 11.5 | 1.0 | 11.5 | |
| | | 5.0 ⁽²⁾ | 15 | | | 3.3 | 5.0 | 1.0 | 6.0 | 1.0 | 6.0 | |
| | | 5.0 ⁽²⁾ | 50 | | | 4.8 | 7.0 | 1.0 | 8.0 | 1.0 | 8.0 | |

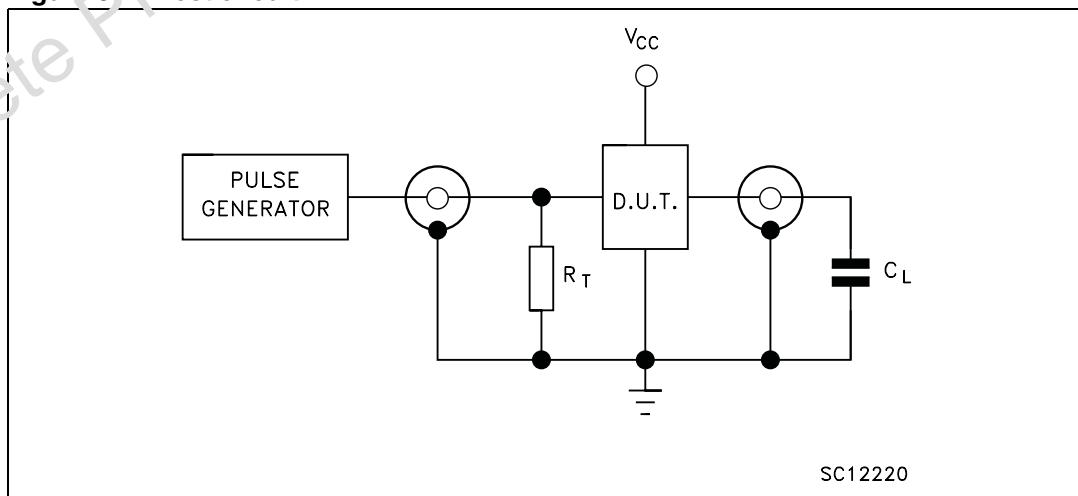
1. Voltage range is 3.3 V ± 0.3 V.

2. Voltage range is 5.0 V ± 0.5 V.

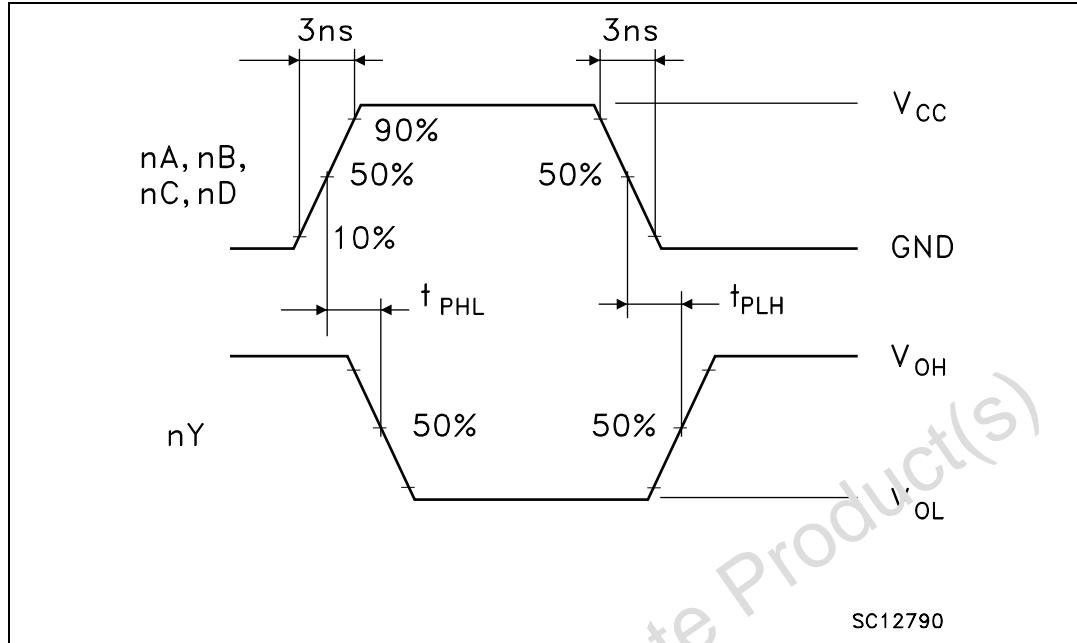
Table 7. Capacitive characteristics

| Symbol | Parameter | Test condition | | | Value | | | | | | Unit | |
|----------|--|----------------|------|------|--------------------------|------|------|------------------------------------|------|-------------------------------------|------|--|
| | | | | | $T_A = 25^\circ\text{C}$ | | | $-40 \text{ to } 85^\circ\text{C}$ | | $-55 \text{ to } 125^\circ\text{C}$ | | |
| | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | | |
| C_{IN} | Input capacitance | | | | 6 | 10 | | 10 | | 10 | pF | |
| C_{PD} | Power dissipation capacitance ⁽¹⁾ | | | | 16 | | | | | | pF | |

1. C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load (refer to [Figure 3](#)). The average operating current can be obtained by the following equation:
 $I_{CC(\text{opr})} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/2$ (per gate).

Figure 3. Test circuit

Note: $C_L = 15/50 \text{ pF}$ or equivalent (includes jig and probe capacitance). $R_T = Z_{OUT}$ of pulse generator (typically 50Ω).

Figure 4. Waveform - propagation delays ($f = 1 \text{ MHz}$, 50% duty cycle)

4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com.
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4.1 SO-14 package information

Figure 5. SO-14 mechanical drawing

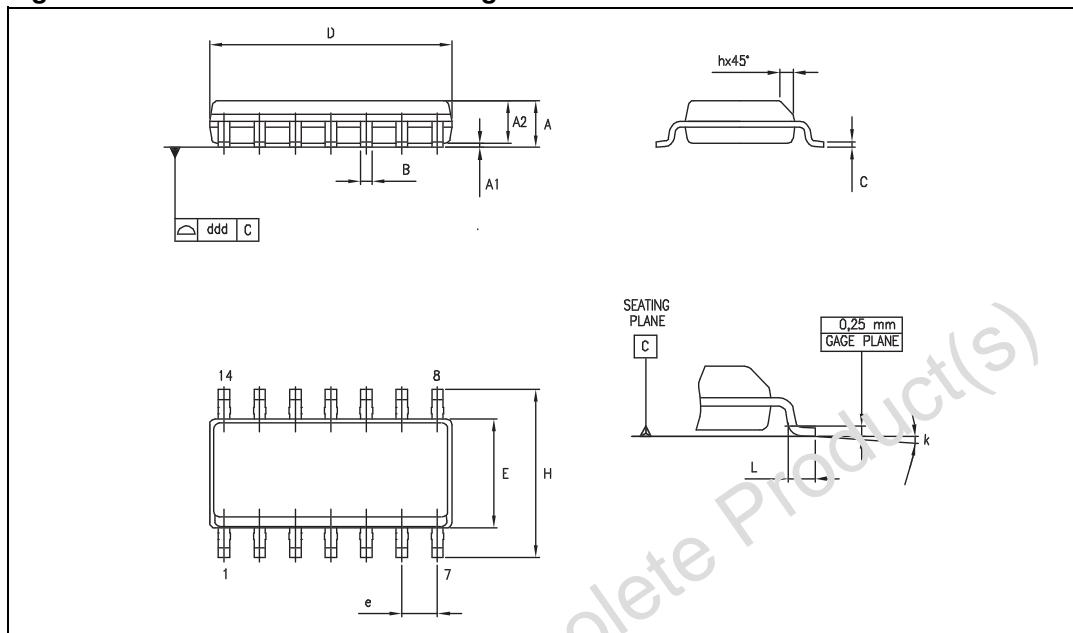


Table 8. SO-14 mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 1.35 | | 1.75 | 0.05 | | 0.068 |
| A1 | 0.10 | | 0.25 | 0.004 | | 0.009 |
| A2 | 1.10 | | 1.65 | 0.04 | | 0.06 |
| B | 0.33 | | 0.51 | 0.01 | | 0.02 |
| C | 0.19 | | 0.25 | 0.007 | | 0.009 |
| D | 8.55 | | 8.75 | 0.33 | | 0.34 |
| E | 3.80 | | 4.0 | 0.15 | | 0.15 |
| e | | 1.27 | | | 0.05 | |
| H | 5.80 | | 6.20 | 0.22 | | 0.24 |
| h | 0.25 | | 0.50 | 0.009 | | 0.02 |
| L | 0.40 | | 1.27 | 0.015 | | 0.05 |
| k | 8° (max.) | | | | | |
| ddd | | | 0.10 | | | 0.004 |

4.2 TSSOP14 package information

Figure 6. TSSOP14 mechanical drawing

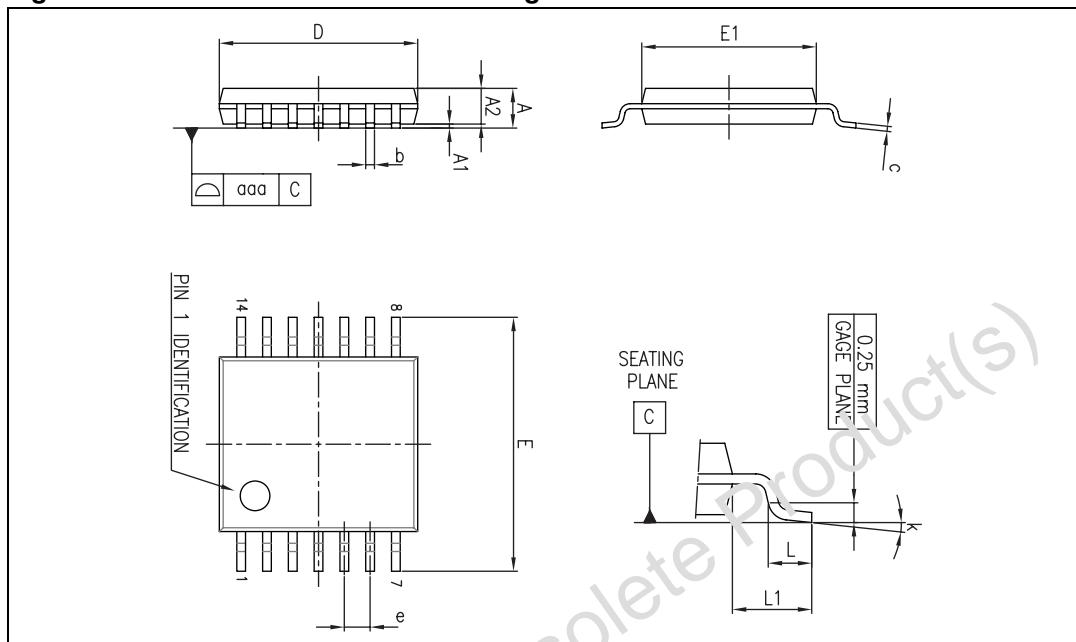


Table 9. TSSOP14 mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|--------|--------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.20 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0089 |
| D | 4.90 | 5.00 | 5.10 | 0.193 | 0.197 | 0.201 |
| E | 6.20 | 6.40 | 6.60 | 0.244 | 0.252 | 0.260 |
| E1 | 4.30 | 4.40 | 4.50 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 | | | 0.0256 | |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | | 1.00 | | | 0.039 | |
| k | 0° | | 8° | 0° | | 8° |
| aaa | | | 0.10 | | | 0.004 |

4.3 Tape & reel SO-14 package information

Figure 7. Tape & reel SO-14 mechanical drawing

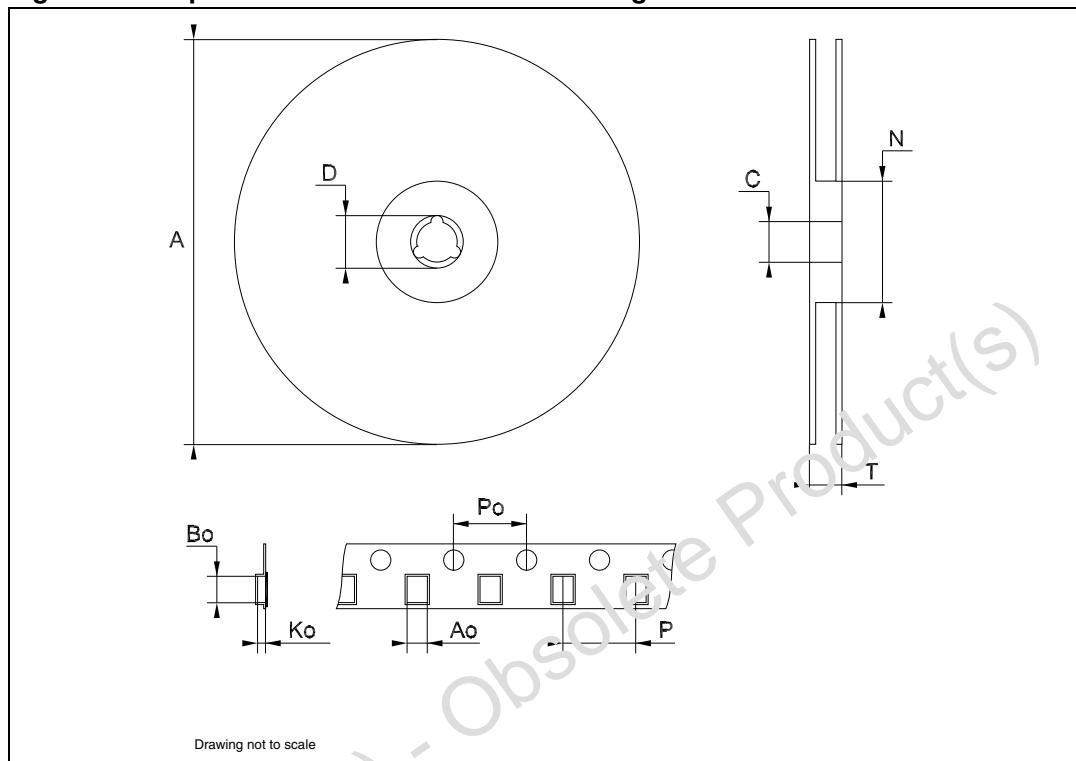


Table 10. Tape & reel SO-14 mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|------|--------|
| | Millimeters | | | Inches | | |
| | 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 | 6.4 | | 6.6 | 0.252 | | 0.260 |
| Bo | 9 | | 9.2 | 0.354 | | 0.362 |
| 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 |

4.4 Tape & reel TSSOP14 package information

Figure 8. Tape & reel TSSOP14 mechanical drawing

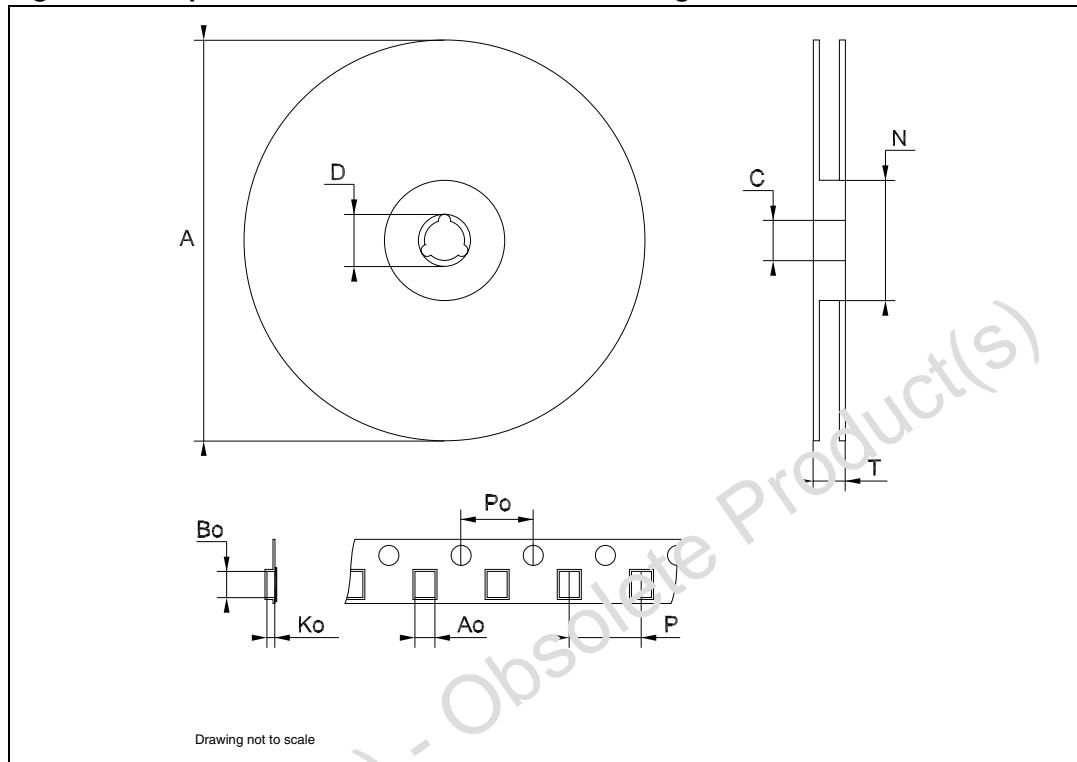


Table 11. Tape & reel TSSOP14 mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|------|--------|
| | Millimeters | | | Inches | | |
| | 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 |

5 Ordering information

Table 12. Order codes

| Order code | Package | Packing |
|------------|---------|-------------|
| 74VHC20MTR | SO-14 | Tape & reel |
| 74VHC20TTR | TSSOP14 | |

6 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 12-Nov-2004 | 4 | Updated order codes in Table 12 . |
| 24-Jan-2012 | 5 | Removed <i>Obsolete Product</i> watermark. Reformatted entire document. |

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