# XC7SET14

## Inverting Schmitt trigger

**Rev. 01 — 31 August 2009**                                   **Product data sheet**

## 1. General description

XC7SET14 is a high-speed Si-gate CMOS device. It provides an inverting buffer function with Schmitt trigger action. This device is capable of transforming slowly changing input signals into sharply defined, jitter-free output signals.

## 2. Features

- Symmetrical output impedance
- High noise immunity
- ESD protection:
  - HBM JESD22-A114E: exceeds 2000 V
  - MM JESD22-A115-A: exceeds 200 V
  - CDM JESD22-C101C: exceeds 1000 V
- Low power dissipation
- Balanced propagation delays
- SOT353-1 and SOT753 package options
- Specified from −40 °C to +125 °C

## 3. Applications

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

## 4. Ordering information

**Table 1.     Ordering information**

| Type number | Package | | | | |
| --- | --- | --- | --- | --- | --- |
| | **Temperature range** | **Name** | **Description** | | **Version** |
| XC7SET14GW | −40 °C to +125 °C | TSSOP5 | plastic thin shrink small outline package; 5 leads; body width 1.25 mm | | SOT353-1 |
| XC7SET14GV | −40 °C to +125 °C | SC-74A | plastic surface-mounted package; 5 leads | | SOT753 |

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## 5. Marking

**Table 2.    Marking codes**

| Type number | Marking code[1] |
|---|---|
| XC7SET14GW | gF |
| XC7SET14GV | g14 |

[1]    The pin 1 indicator is located on the lower left corner of the device, below the marking code.

## 6. Functional diagram



**Fig 1.    Logic symbol**

**Fig 2.    IEC logic symbol**

**Fig 3.    Logic diagram**
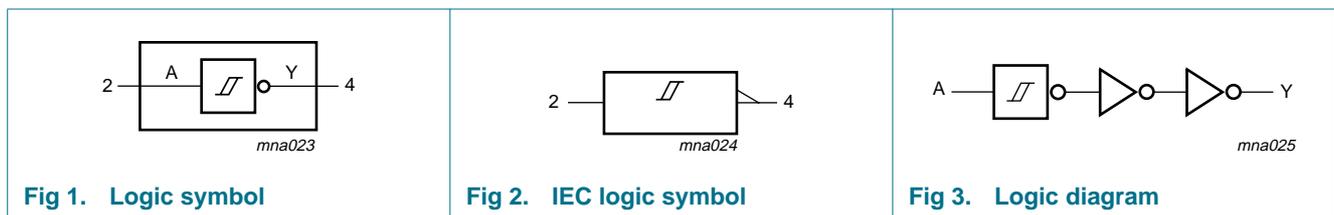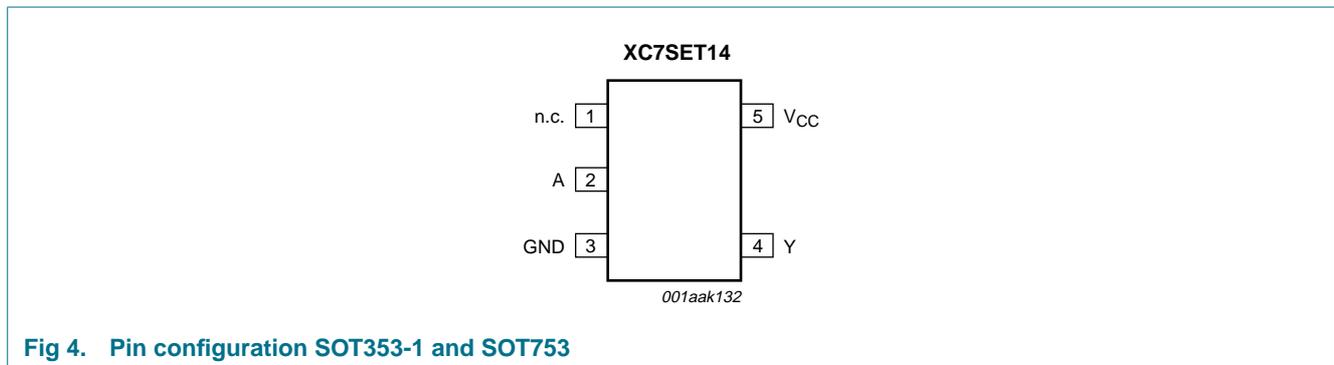
## 7. Pinning information

### 7.1 Pinning



**Fig 4.    Pin configuration SOT353-1 and SOT753**

### 7.2 Pin description

**Table 3.    Pin description**

| Symbol | Pin | Description |
|---|---|---|
| n.c. | 1 | not connected |
| A | 2 | data input |
| GND | 3 | ground (0 V) |
| Y | 4 | data output |
| $V_{CC}$ | 5 | supply voltage |

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## 8. Functional description

**Table 4.    Function table**
*H = HIGH voltage level; L = LOW voltage level*

| Input | Output |
|-------|--------|
| **A** | **Y** |
| L | H |
| H | L |

## 9. Limiting values

**Table 5.    Limiting values**
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|--------|-----------|------------|---|-----|-----|------|
| $V_{CC}$ | supply voltage | | | −0.5 | +7.0 | V |
| $V_I$ | input voltage | | | −0.5 | +7.0 | V |
| $I_{IK}$ | input clamping current | $V_I < -0.5$ V | | −20 | - | mA |
| $I_{OK}$ | output clamping current | $V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V | [1] | - | ±20 | mA |
| $I_O$ | output current | $-0.5$ V $< V_O < V_{CC} + 0.5$ V | | - | ±25 | mA |
| $I_{CC}$ | supply current | | | - | 75 | mA |
| $I_{GND}$ | ground current | | | −75 | - | mA |
| $T_{stg}$ | storage temperature | | | −65 | +150 | °C |
| $P_{tot}$ | total power dissipation | $T_{amb} = -40$ °C to +125 °C | [2] | - | 250 | mW |

[1]    The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2]    For both TSSOP5 and SC-74A packages: above 87.5 °C the value of $P_{tot}$ derates linearly with 4.0 mW/K.

## 10. Recommended operating conditions

**Table 6.    Recommended operating conditions**
*Voltages are referenced to GND (ground = 0 V).*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|-----------|------------|-----|-----|-----|------|
| $V_{CC}$ | supply voltage | | 4.5 | 5.0 | 5.5 | V |
| $V_I$ | input voltage | | 0 | - | 5.5 | V |
| $V_O$ | output voltage | | 0 | - | $V_{CC}$ | V |
| $T_{amb}$ | ambient temperature | | −40 | +25 | +125 | °C |

## 11. Static characteristics

**Table 7.    Static characteristics**
*Voltages are referenced to GND (ground = 0 V).*

| Symbol | Parameter | Conditions | 25 °C | | | −40 °C to +85 °C | | −40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Min** | **Typ** | **Max** | **Min** | **Max** | **Min** | **Max** | |
| $V_{OH}$ | HIGH-level output voltage | $V_I = V_{T+}$ or $V_{T-}$; $V_{CC} = 4.5$ V | | | | | | | | |
| | | $I_O = -50$ μA | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V |
| | | $I_O = -8.0$ mA | 3.94 | - | - | 3.8 | - | 3.70 | - | V |
| $V_{OL}$ | LOW-level output voltage | $V_I = V_{T+}$ or $V_{T-}$; $V_{CC} = 4.5$ V | | | | | | | | |
| | | $I_O = 50$ μA | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | $I_O = 8.0$ mA | - | - | 0.36 | - | 0.44 | - | 0.55 | V |
| $I_I$ | input leakage current | $V_I = 5.5$ V or GND; $V_{CC} = 0$ V to 5.5 V | - | - | 0.1 | - | 1.0 | - | 2.0 | μA |
| $I_{CC}$ | supply current | $V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5$ V | - | - | 1.0 | - | 10 | - | 40 | μA |
| $\Delta I_{CC}$ | additional supply current | per input pin; $V_I = 3.4$ V; other inputs at $V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5$ V | - | - | 1.35 | - | 1.5 | - | 1.5 | mA |
| $C_I$ | input capacitance | | - | 1.5 | 10 | - | 10 | - | 10 | pF |

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### 11.1 Transfer characteristics

**Table 8.    Transfer characteristics**

*At recommended operating conditions; voltages are referenced to GND (ground = 0 V). See Figure 7 and Figure 8.*

| Symbol | Parameter | Conditions | 25 °C | | | −40 °C to +85 °C | | −40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| $V_{T+}$ | positive-going threshold voltage | $V_{CC}$ = 4.5 V | - | - | 2.0 | - | 2.0 | - | 2.0 | V |
| | | $V_{CC}$ = 5.5 V | - | - | 2.0 | - | 2.0 | - | 2.0 | V |
| $V_{T−}$ | negative-going threshold voltage | $V_{CC}$ = 4.5 V | 0.5 | - | - | 0.5 | - | 0.5 | - | V |
| | | $V_{CC}$ = 5.5 V | 0.6 | - | - | 0.6 | - | 0.6 | - | V |
| $V_H$ | hysteresis voltage | $V_{CC}$ = 4.5 V | 0.4 | - | 1.4 | 0.4 | 1.4 | 0.35 | 1.4 | V |
| | | $V_{CC}$ = 5.5 V | 0.4 | - | 1.6 | 0.4 | 1.6 | 0.35 | 1.6 | V |

## 12. Dynamic characteristics

**Table 9.    Dynamic characteristics**

*GND = 0 V. For waveform see Figure 5. For test circuit see Figure 6.*

| Symbol | Parameter | Conditions | | 25 °C | | | −40 °C to +85 °C | | −40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Min | Max | Min | Max | |
| $t_{pd}$ | propagation delay | A to Y; $V_{CC}$ = 4.5 V to 5.5 V | [1] [2] | | | | | | | | |
| | | $C_L$ = 15 pF | | - | 4.1 | 7.0 | 1.0 | 8.0 | 1.0 | 9.0 | ns |
| | | $C_L$ = 50 pF | | - | 5.9 | 8.5 | 1.0 | 10.0 | 1.0 | 11.0 | ns |
| $C_{PD}$ | power dissipation capacitance | per buffer; $V_I$ = GND to $V_{CC}$ | [3] | - | 13 | - | - | - | - | - | pF |

[1]    $t_{pd}$ is the same as $t_{PLH}$ and $t_{PHL}$.

[2]    Typical values are measured at $V_{CC}$ = 5.0 V.

[3]    $C_{PD}$ is used to determine the dynamic power dissipation $P_D$ (µW).

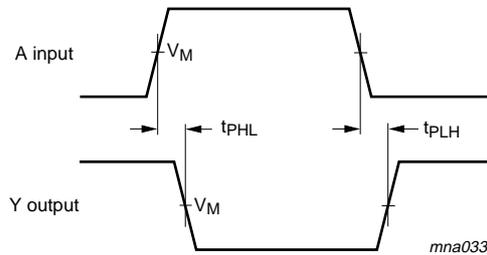$P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma(C_L \times V_{CC}^2 \times f_o)$ where:

$f_i$ = input frequency in MHz;

$f_o$ = output frequency in MHz;

$C_L$ = output load capacitance in pF;

$V_{CC}$ = supply voltage in V.

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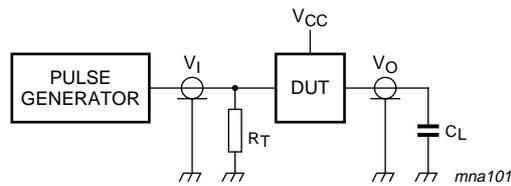
# 13. Waveforms



Measurement points are given in Table 10.

**Fig 5.   The input (A) to output (Y) propagation delays**

**Table 10.   Measurement points**

| Type number | Input | | Output |
|---|---|---|---|
| | $V_I$ | $V_M$ | $V_M$ |
| XC7SET14 | GND to 3.0 V | 1.5 V | $0.5 \times V_{CC}$ |



Test data is given in Table 11.

Definitions for test circuit:

$C_L$ = Load capacitance including jig and probe capacitance.

$R_T$ = Termination resistance should be equal to output impedance $Z_o$ of the pulse generator.

**Fig 6.   Load circuitry for switching times**

**Table 11.   Test data**

| Type | Input | | Load | Test |
|---|---|---|---|---|
| | $V_I$ | $t_r$, $t_f$ | $C_L$ | |
| XC7SET14 | 3.0 V | $\leq 3.0$ ns | 15 pF, 50 pF | $t_{PLH}$, $t_{PHL}$ |

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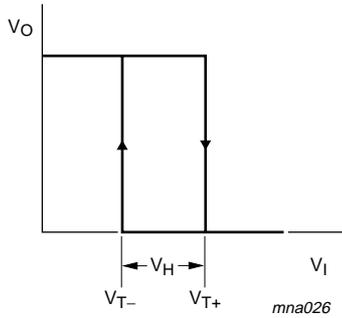
### 13.1 Transfer characteristic waveforms



Fig 7.   Transfer characteristic


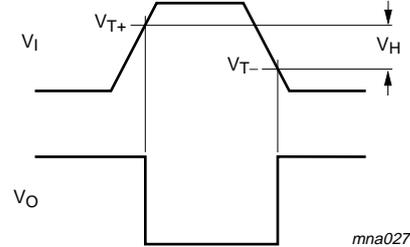
Fig 8.   The definitions of $V_{T+}$, $V_{T-}$ and $V_H$
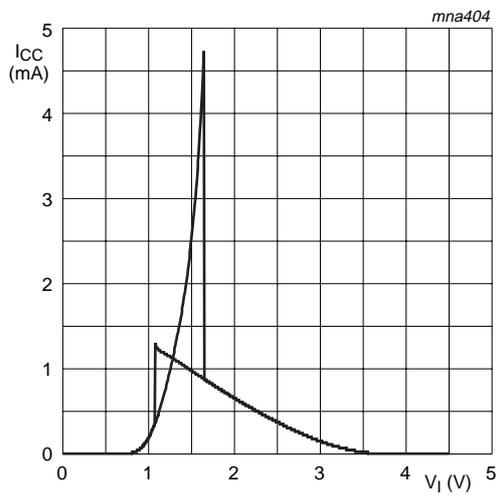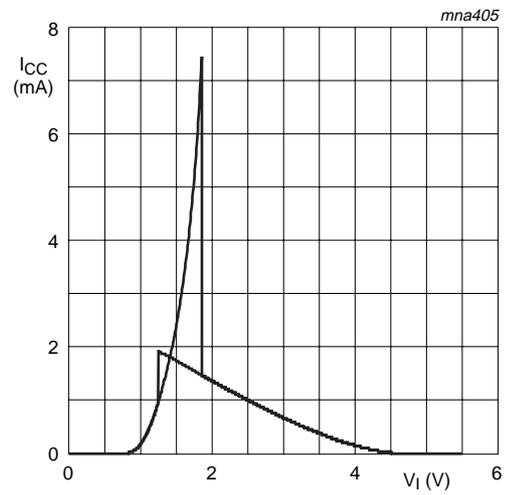


Fig 9.   Typical characteristics; $V_{CC}$ = 4.5 V



Fig 10.   Typical transfer characteristics; $V_{CC}$ = 5.5 V

## 14. Application information

The slow input rise and fall times cause additional power dissipation, which can be calculated using the following formula:

$P_{add} = f_i \times (t_r \times \Delta I_{CC(AV)} + t_f \times \Delta I_{CC(AV)}) \times V_{CC}$ where:

$P_{add}$ = additional power dissipation ($\mu$W);

$f_i$ = input frequency (MHz);

$t_r$ = input rise time (ns); 10 % to 90 %;

$t_f$ = input fall time (ns); 90 % to 10 %;

$\Delta I_{CC(AV)}$ = average additional supply current ($\mu$A).

Average additional $I_{CC}$ differs with positive or negative input transitions, as shown in Figure 11.

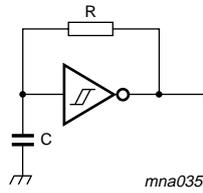For XC7SET14 used in relaxation oscillator circuit, see Figure 12.

**Note to the application information:**

1. All values given are typical unless otherwise specified.



*mna058*
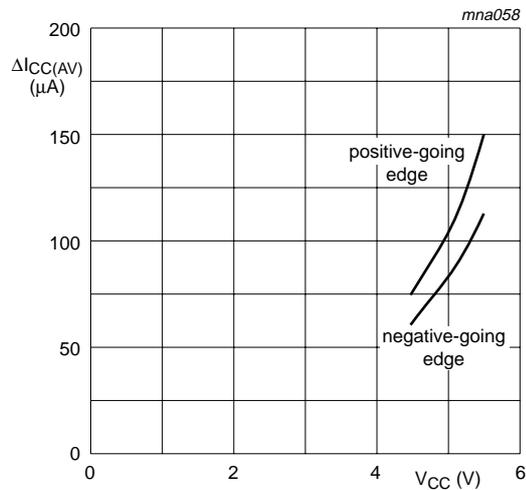
Linear change of $V_I$ between $0.1V_{CC}$ to $0.9V_{CC}$

**Fig 11.  Average additional I$_{CC}$**

$$f = \frac{1}{T} \approx \frac{1}{0.60 \times RC}$$

**Fig 12. Relaxation oscillator using the XC7SET14**

## 15. Package outline

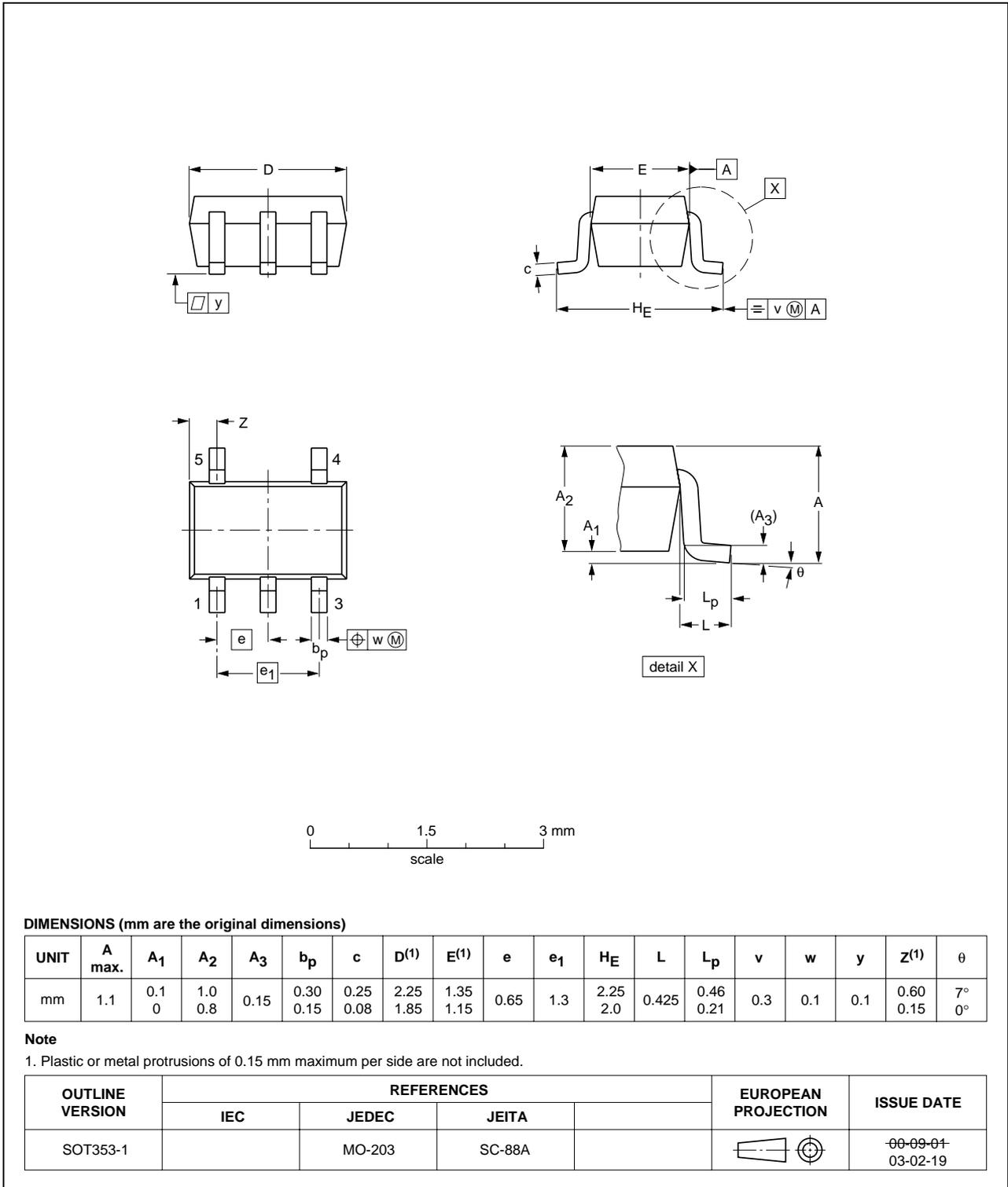TSSOP5: plastic thin shrink small outline package; 5 leads; body width 1.25 mm     SOT353-1



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | A₁ | A₂ | A₃ | bₚ | c | D(1) | E(1) | e | e₁ | HE | L | Lₚ | v | w | y | Z(1) | θ |
|------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| mm | 1.1 | 0.1 0 | 1.0 0.8 | 0.15 | 0.30 0.15 | 0.25 0.08 | 2.25 1.85 | 1.35 1.15 | 0.65 | 1.3 | 2.25 2.0 | 0.425 | 0.46 0.21 | 0.3 | 0.1 | 0.1 | 0.60 0.15 | 7° 0° |

**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|------|-------|---|---------------------|------------|
| | IEC | JEDEC | JEITA | | | |
| SOT353-1 | | MO-203 | SC-88A | | | ~~00-09-01~~ 03-02-19 |

**Fig 13. Package outline SOT353-1 (TSSOP5)**

**Plastic surface-mounted package; 5 leads**           **SOT753**



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | A₁ | bp | c | D | E | e | HE | Lp | Q | v | w | y |
|------|-----|-------|------|------|-----|-----|------|-----|-----|------|-----|-----|-----|
| mm | 1.1<br>0.9 | 0.100<br>0.013 | 0.40<br>0.25 | 0.26<br>0.10 | 3.1<br>2.7 | 1.7<br>1.3 | 0.95 | 3.0<br>2.5 | 0.6<br>0.2 | 0.33<br>0.23 | 0.2 | 0.2 | 0.1 |

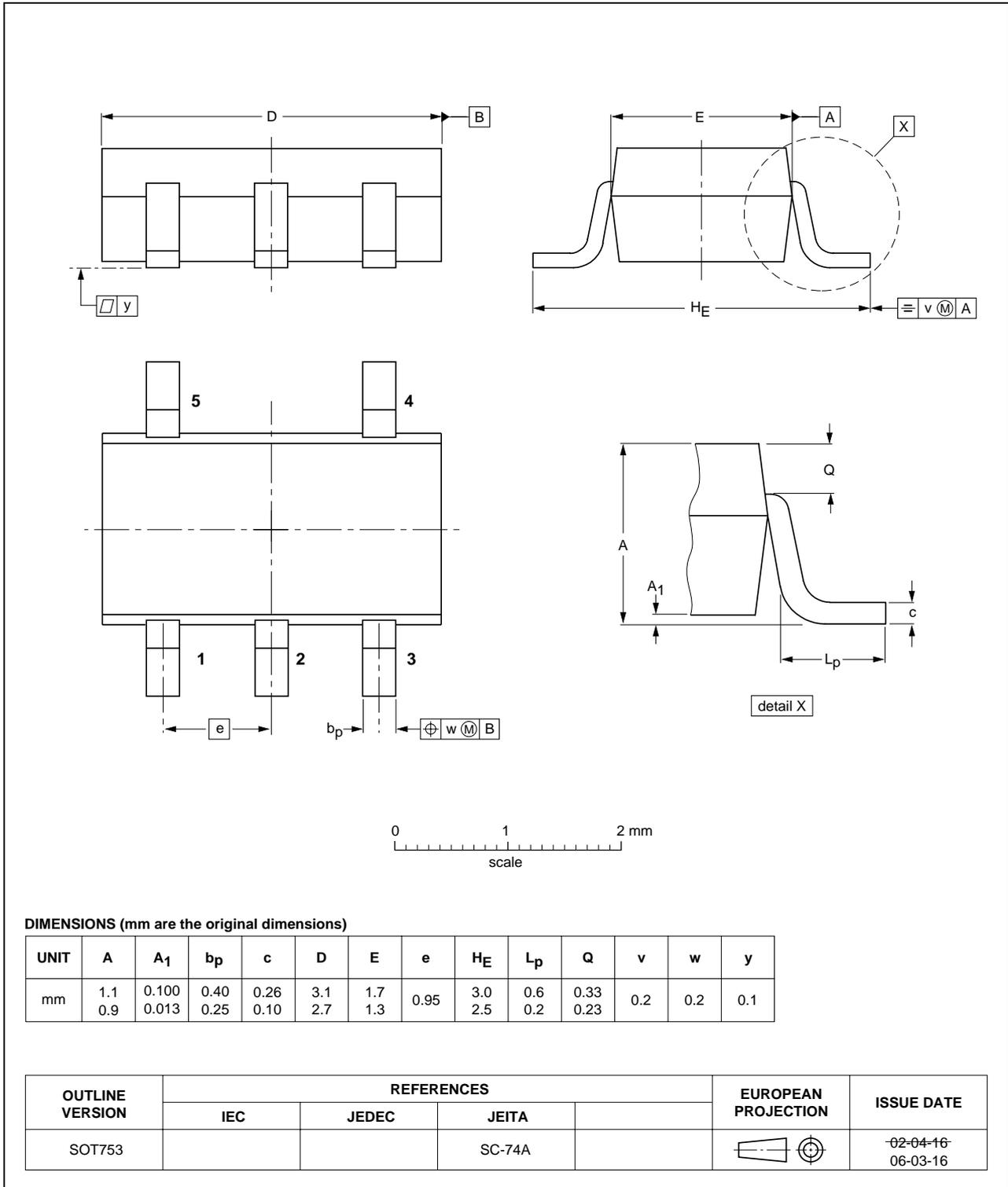| OUTLINE<br>VERSION | REFERENCES | | | | EUROPEAN<br>PROJECTION | ISSUE DATE |
|--------------------|------------|-------|-------|---|------------------------|-------------|
| | IEC | JEDEC | JEITA | | | |
| SOT753 | | | SC-74A | | | 02-04-16<br>06-03-16 |

**Fig 14.  Package outline SOT753 (SC-74A)**

# 16. Abbreviations

**Table 12. Abbreviations**

| Acronym | Description |
|---------|-------------|
| CDM | Charged Device Model |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |

# 17. Revision history

**Table 13. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|-------------|--------------|-------------------|---------------|------------|
| XC7SET14_1 | 20090831 | Product data sheet | - | - |

# 18. Legal information

## 18.1 Data sheet status

| Document status[1][2] | Product status[3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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