

# XC7SH14

## Inverting Schmitt trigger

Rev. 01 — 1 September 2009

Product data sheet

## 1. General description

XC7SH14 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 impedances
- 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  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

## 3. Applications

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

## 4. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
XC7SH14GW	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP5	plastic thin shrink small outline package; 5 leads; body width 1.25 mm	SOT353-1
XC7SH14GV	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SC-74A	plastic surface-mounted package; 5 leads	SOT753

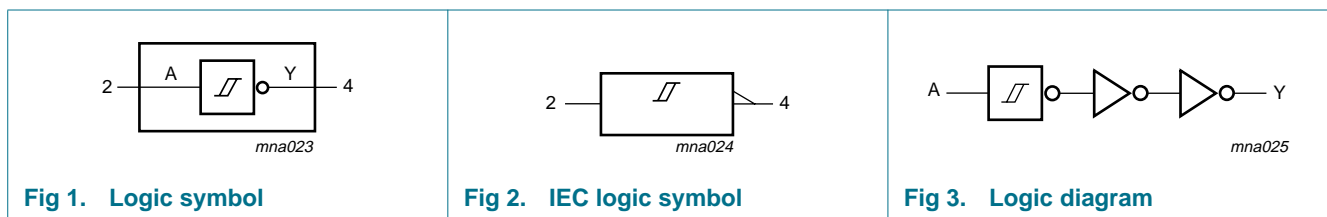
## 5. Marking

Table 2. Marking codes

Type number	Marking code <sup>[1]</sup>
XC7SH14GW	fF
XC7SH14GV	f14

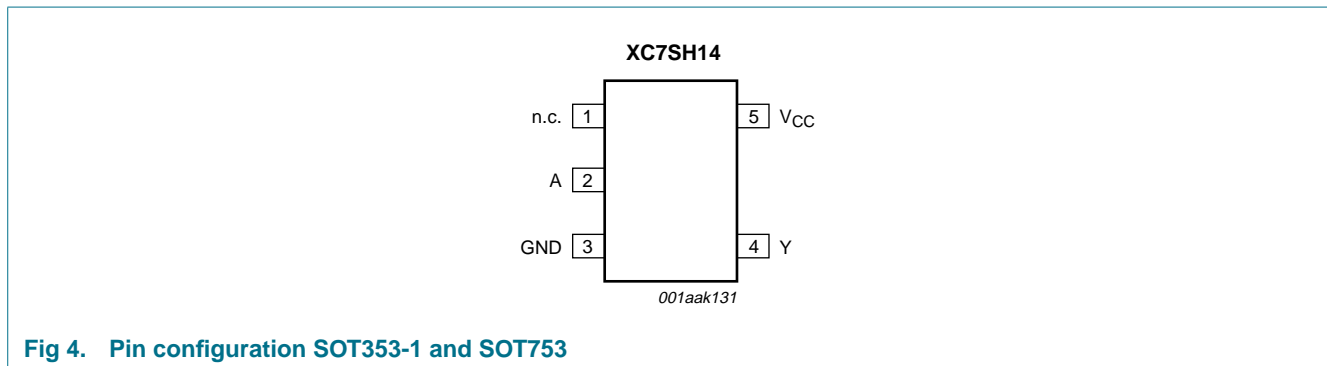
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

## 6. Functional diagram



## 7. Pinning information

### 7.1 Pinning



### 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 <sub>CC</sub>	5	supply voltage

## 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		2.0	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 <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub>								
		I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 3.0 V	2.9	3.0	-	2.9	-	2.9	-	V
		I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 3.0 V	2.58	-	-	2.48	-	2.40	-	V
		I <sub>O</sub> = -8.0 mA; V <sub>CC</sub> = 4.5 V	3.94	-	-	3.8	-	3.70	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub>								
		I <sub>O</sub> = 50 μA; V <sub>CC</sub> = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 50 μA; V <sub>CC</sub> = 3.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 50 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 3.0 V	-	-	0.36	-	0.44	-	0.55	V
		I <sub>O</sub> = 8.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.36	-	0.44	-	0.55	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; V <sub>CC</sub> = 0 V to 5.5 V	-	-	0.1	-	1.0	-	2.0	μA
I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 5.5 V	-	-	1.0	-	10	-	40	μA
C <sub>I</sub>	input capacitance		-	1.5	10	-	10	-	10	pF

## 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 <sub>T+</sub>	positive-going threshold voltage	V <sub>CC</sub> = 3.0 V	-	-	2.2	-	2.2	-	2.2	V
		V <sub>CC</sub> = 4.5 V	-	-	3.15	-	3.15	-	3.15	V
		V <sub>CC</sub> = 5.5 V	-	-	3.85	-	3.85	-	3.85	V
V <sub>T-</sub>	negative-going threshold voltage	V <sub>CC</sub> = 3.0 V	0.9	-	-	0.9	-	0.9	-	V
		V <sub>CC</sub> = 4.5 V	1.35	-	-	1.35	-	1.35	-	V
		V <sub>CC</sub> = 5.5 V	1.65	-	-	1.65	-	1.65	-	V
V <sub>H</sub>	hysteresis voltage	V <sub>CC</sub> = 3.0 V	0.3	-	1.2	0.3	1.2	0.25	1.2	V
		V <sub>CC</sub> = 4.5 V	0.4	-	1.4	0.4	1.4	0.35	1.4	V
		V <sub>CC</sub> = 5.5 V	0.5	-	1.6	0.5	1.6	0.45	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 <sub>pd</sub>	propagation delay	A to Y; <a href="#">[1]</a>								
		V <sub>CC</sub> = 3.0 V to 3.6 V <a href="#">[2]</a>								
		C <sub>L</sub> = 15 pF	-	4.2	12.8	1.0	15.0	1.0	16.5	ns
		C <sub>L</sub> = 50 pF	-	6.0	16.3	1.0	18.5	1.0	20.5	ns
		V <sub>CC</sub> = 4.5 V to 5.5 V <a href="#">[3]</a>								
		C <sub>L</sub> = 15 pF	-	3.2	8.6	1.0	10.0	1.0	11.0	ns
C <sub>PD</sub>	power dissipation capacitance	C <sub>L</sub> = 50 pF; f = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub>	-	12	-	-	-	-	-	pF

[1] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.

[2] Typical values are measured at V<sub>CC</sub> = 3.3 V.

[3] Typical values are measured at V<sub>CC</sub> = 5.0 V.

[4] C<sub>PD</sub> is used to determine the dynamic power dissipation P<sub>D</sub> (μW).

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

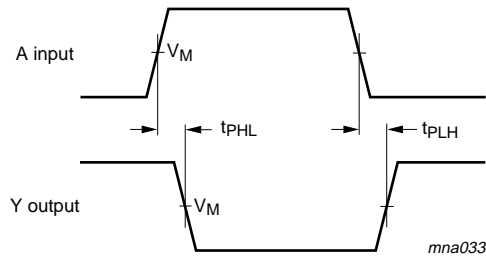
f<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in Volts.

**13. Waveforms**

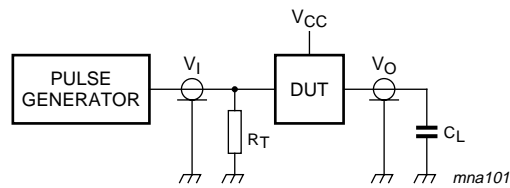


Measurement points are given in [Table 10](#).

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

**Table 10. Measurement points**

Type number	Input		Output
	$V_I$	$V_M$	$V_M$
XC7SH14	GND to $V_{CC}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$



Test data is given in [Table 11](#).

Definitions for test circuit:

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

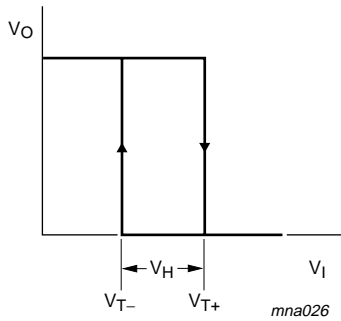
$R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

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

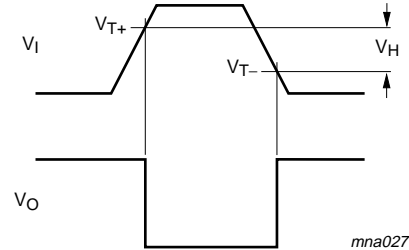
**Table 11. Test data**

Type	Input		Load	Test
	$V_I$	$t_r, t_f$	$C_L$	
XC7SH14	$V_{CC}$	$\leq 3.0$ ns	15 pF, 50 pF	$t_{PLH}, t_{PHL}$

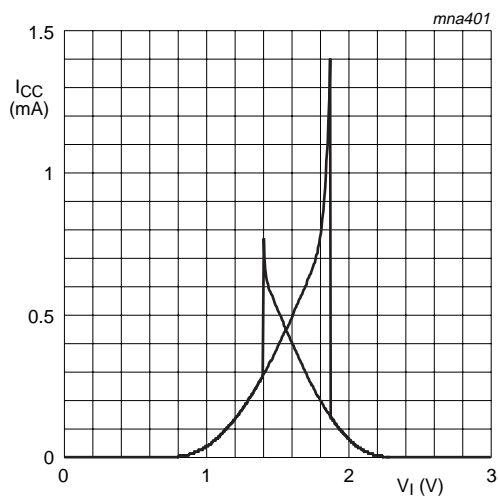
**13.1 Transfer characteristic waveforms**



**Fig 7. Transfer characteristic**

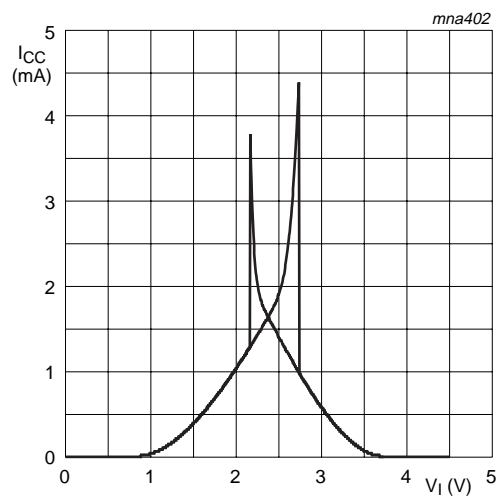


**Fig 8. The definitions of  $V_{T+}$ ,  $V_{T-}$  and  $V_H$**



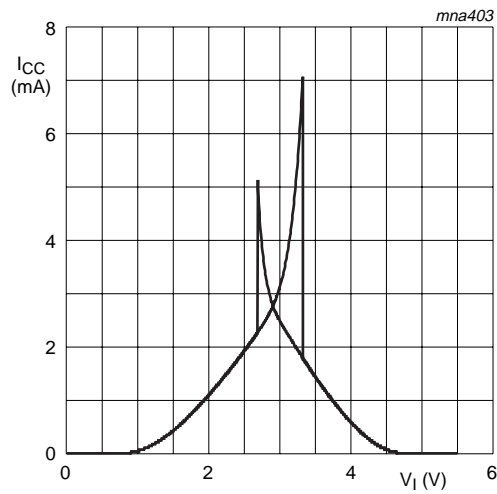
$V_{CC} = 3.0\text{ V}$ .

**Fig 9. Typical transfer characteristics**



$V_{CC} = 4.5\text{ V}$ .

**Fig 10. Typical transfer characteristics**



$V_{CC} = 5.5 \text{ V}$ .

Fig 11. Typical transfer characteristics

## 14. Application information

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

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

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

$f_i$  = input frequency (MHz);

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

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

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

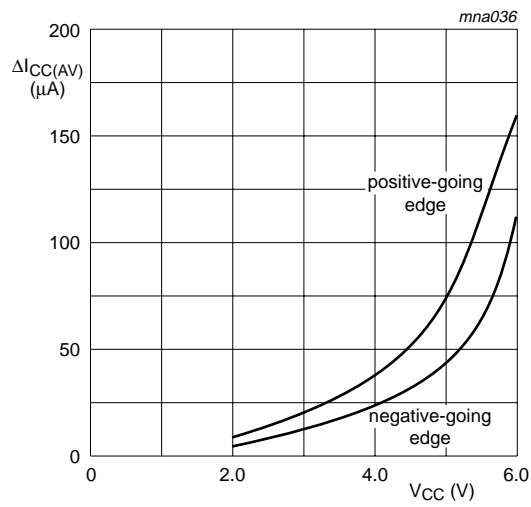
Average additional  $I_{\text{CC}}$  differs with positive or negative input transitions, as shown in [Figure 12](#).

For XC7SH14 used in relaxation oscillator circuit, see [Figure 13](#).

### Note to the application information:

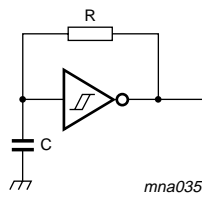
1. All values given are typical unless otherwise specified.





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

**Fig 12. Average additional  $I_{CC}$**



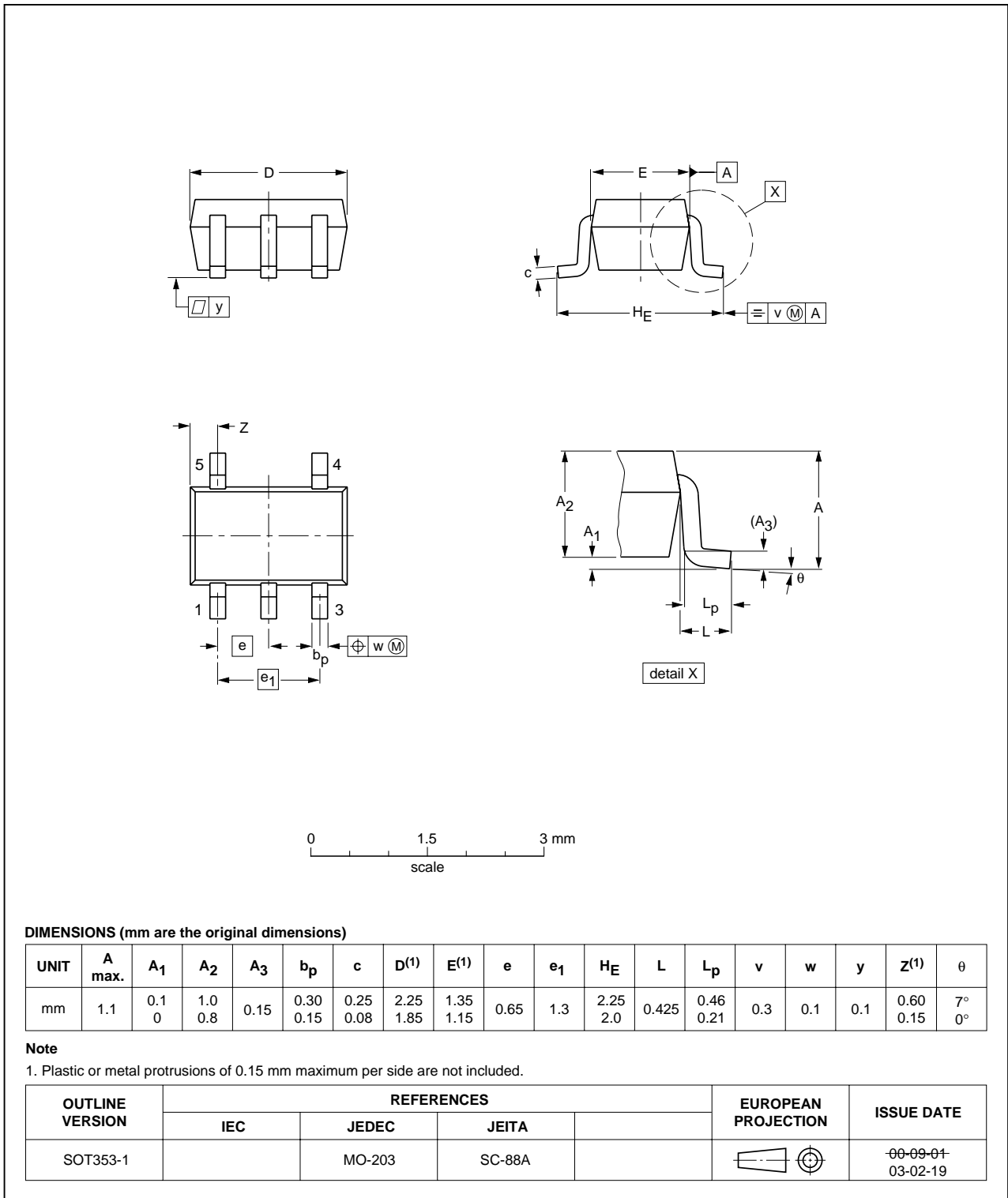
$$f = \frac{1}{T} \approx \frac{1}{0.55 \times RC}$$

**Fig 13. Relaxation oscillator using the XC7SH14**

**15. Package outline**

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

SOT353-1



**Fig 14. Package outline SOT353-1 (TSSOP5)**

Plastic surface-mounted package; 5 leads

SOT753

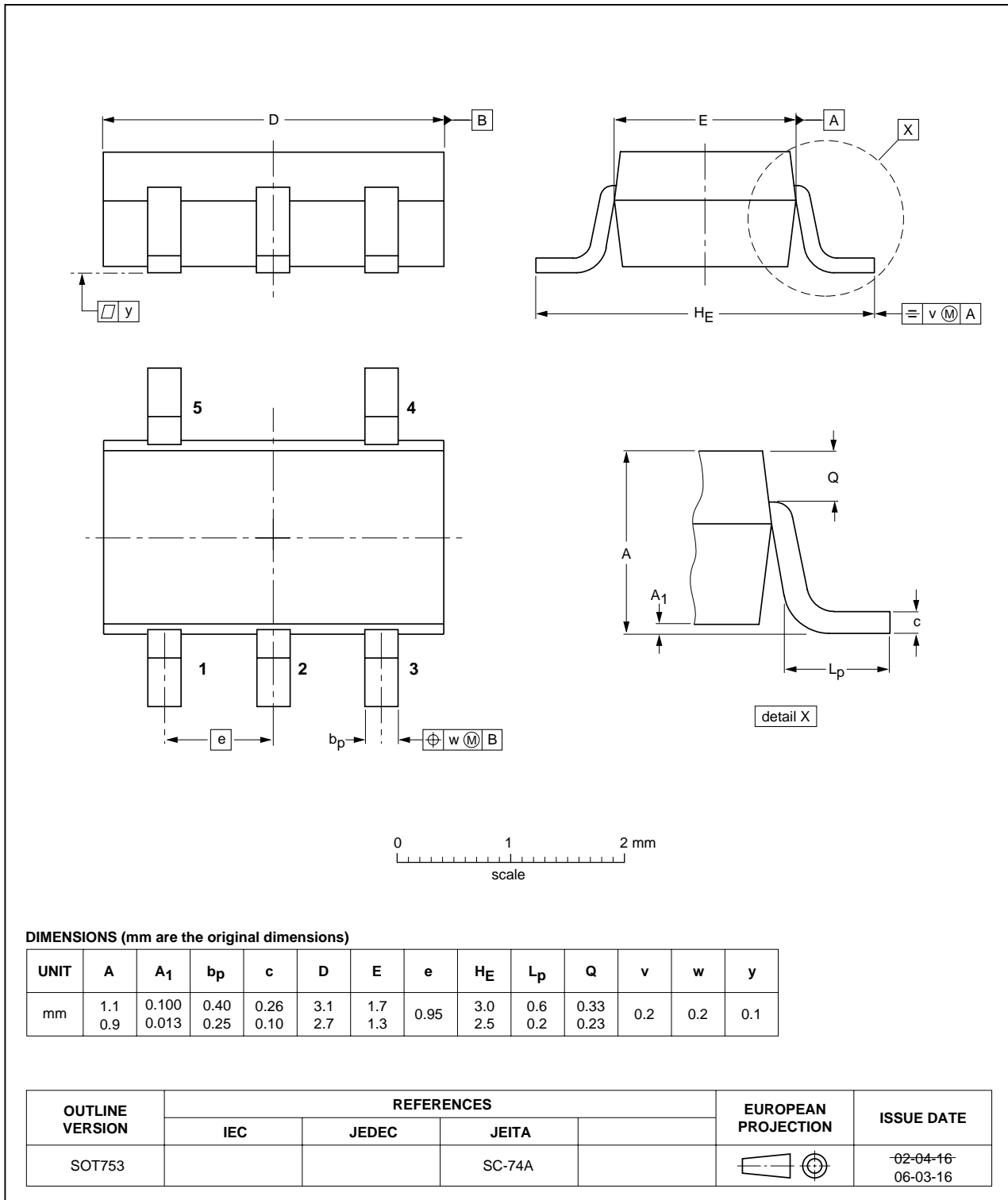


Fig 15. Package outline SOT753 (SC-74A)

## 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
TTL	Transistor-Transistor Logic

## 17. Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
XC7SH14_1	20090901	Product data sheet	-	-

## 18. Legal information

### 18.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
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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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## 20. Contents

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<b>1</b>	<b>General description</b> . . . . .	<b>1</b>
<b>2</b>	<b>Features</b> . . . . .	<b>1</b>
<b>3</b>	<b>Applications</b> . . . . .	<b>1</b>
<b>4</b>	<b>Ordering information</b> . . . . .	<b>1</b>
<b>5</b>	<b>Marking</b> . . . . .	<b>2</b>
<b>6</b>	<b>Functional diagram</b> . . . . .	<b>2</b>
<b>7</b>	<b>Pinning information</b> . . . . .	<b>2</b>
7.1	Pinning . . . . .	2
7.2	Pin description . . . . .	2
<b>8</b>	<b>Functional description</b> . . . . .	<b>3</b>
<b>9</b>	<b>Limiting values</b> . . . . .	<b>3</b>
<b>10</b>	<b>Recommended operating conditions</b> . . . . .	<b>3</b>
<b>11</b>	<b>Static characteristics</b> . . . . .	<b>4</b>
11.1	Transfer characteristics . . . . .	5
<b>12</b>	<b>Dynamic characteristics</b> . . . . .	<b>5</b>
<b>13</b>	<b>Waveforms</b> . . . . .	<b>6</b>
13.1	Transfer characteristic waveforms . . . . .	7
<b>14</b>	<b>Application information</b> . . . . .	<b>8</b>
<b>15</b>	<b>Package outline</b> . . . . .	<b>10</b>
<b>16</b>	<b>Abbreviations</b> . . . . .	<b>12</b>
<b>17</b>	<b>Revision history</b> . . . . .	<b>12</b>
<b>18</b>	<b>Legal information</b> . . . . .	<b>13</b>
18.1	Data sheet status . . . . .	13
18.2	Definitions . . . . .	13
18.3	Disclaimers . . . . .	13
18.4	Trademarks . . . . .	13
<b>19</b>	<b>Contact information</b> . . . . .	<b>13</b>
<b>20</b>	<b>Contents</b> . . . . .	<b>14</b>

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