

# 74AHC1G66-Q100; 74AHCT1G66-Q100

Single-pole single-throw analog switch

Rev. 1 — 27 January 2015

Product data sheet

## 1. General description

74AHC1G66-Q100 and 74AHCT1G66-Q100 are high-speed Si-gate CMOS devices. They are single-pole single-throw analog switches. The switch has two input/output pins (Y and Z) and an active HIGH enable input pin (E). When pin E is LOW, the analog switch is turned off.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

## 2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - ◆ Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Very low ON resistance:
  - ◆  $26\ \Omega$  (typ.) at  $V_{CC} = 3.0\text{ V}$
  - ◆  $16\ \Omega$  (typ.) at  $V_{CC} = 4.5\text{ V}$
  - ◆  $14\ \Omega$  (typ.) at  $V_{CC} = 5.5\text{ V}$
- High noise immunity
- Low power dissipation
- Balanced propagation delays
- Multiple package options
- ESD protection:
  - ◆ MIL-STD-883, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V ( $C = 200\text{ pF}$ ,  $R = 0\ \Omega$ )

## 3. Ordering information

Table 1. Ordering information

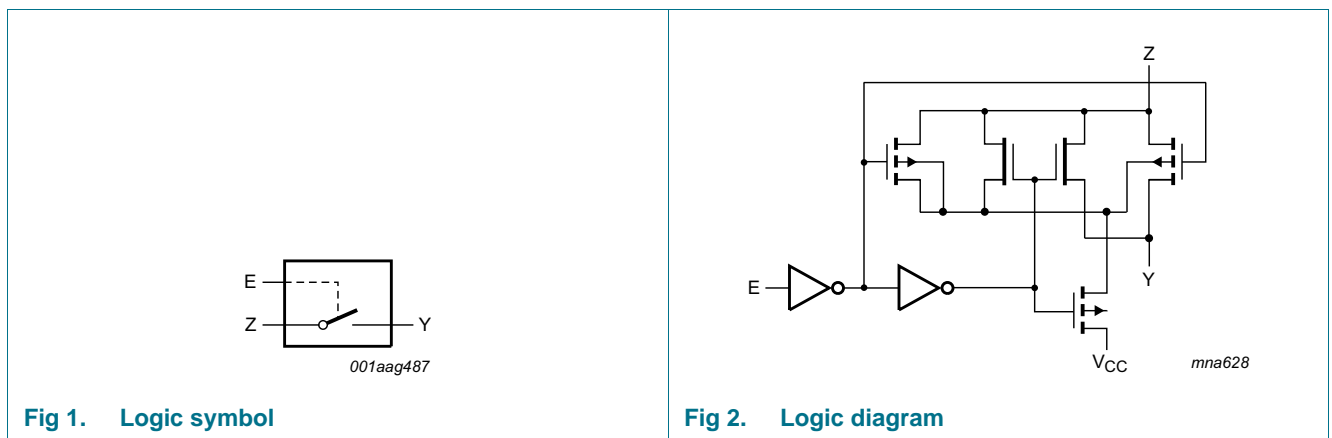
Type number	Package			Version
	Temperature range	Name	Description	
74AHC1G66GW-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP5	plastic thin shrink small outline package; 5 leads; body width 1.25 mm	SOT353-1
74AHCT1G66GW-Q100				
74AHC1G66GV-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SC-74A	plastic surface-mounted package; 5 leads	SOT753
74AHCT1G66GV-Q100				

## 4. Marking

Table 2. Marking codes

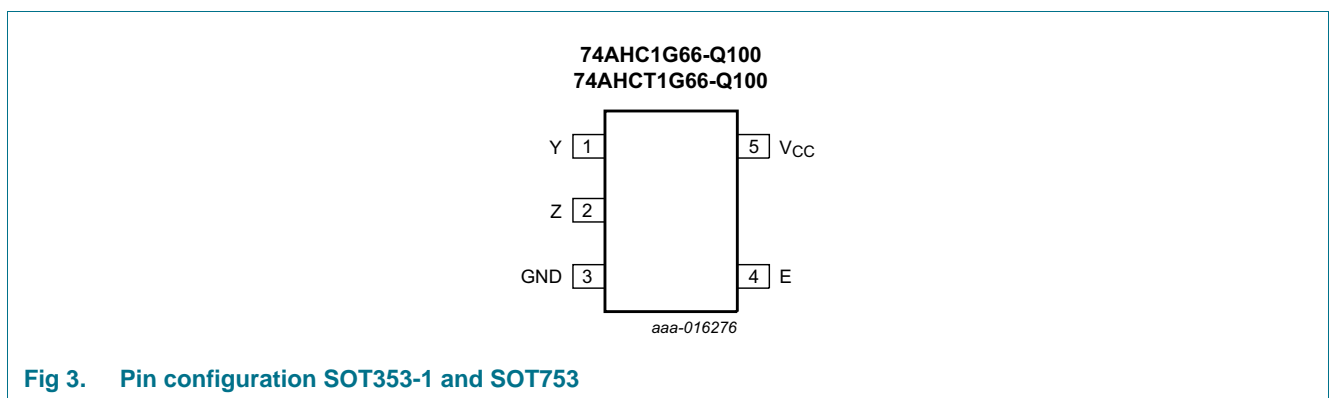
Type number	Marking
74AHC1G66GW-Q100	AL
74AHCT1G66GW-Q100	CL
74AHC1G66GV-Q100	A66
74AHCT1G66GV-Q100	C66

## 5. Functional diagram



## 6. Pinning information

### 6.1 Pinning



## 6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
Y	1	independent input or output
Z	2	independent input or output
GND	3	ground (0 V)
E	4	enable input (active HIGH)
V <sub>CC</sub>	5	supply voltage

## 7. Functional description

Table 4. Function table<sup>[1]</sup>

Input E	Switch
L	OFF
H	ON

[1] H = HIGH voltage level; L = LOW voltage level.

## 8. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>CC</sub>	supply voltage		-0.5	+7.0	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V <sup>[1]</sup>	-20	-	mA
I <sub>SK</sub>	switch clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V <sup>[1]</sup>	-	±20	mA
I <sub>SW</sub>	switch current	-0.5 V < V <sub>O</sub> < V <sub>CC</sub> + 0.5 V	-	±25	mA
I <sub>CC</sub>	supply current		-	75	mA
I <sub>GND</sub>	ground current		-75	-	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = -40 °C to +125 °C <sup>[2]</sup>	-	250	mW

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

[2] For TSSOP5 and SC-74A packages: above 87.5 °C the value of P<sub>tot</sub> derates linearly with 4.0 mW/K.

## 9. Recommended operating conditions

Table 6. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V).<sup>[1]</sup>

Symbol	Parameter	Conditions	74AHC1G66-Q100			74AHCT1G66-Q100			Unit
			Min	Typ	Max	Min	Typ	Max	
V <sub>CC</sub>	supply voltage		2.0	5.0	5.5	4.5	5.0	5.5	V
V <sub>I</sub>	input voltage		0	-	5.5	0	-	5.5	V
V <sub>SW</sub>	switch voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V

**Table 6. Recommended operating conditions ...continued**Voltages are referenced to GND (ground = 0 V).<sup>[1]</sup>

Symbol	Parameter	Conditions	74AHC1G66-Q100			74AHCT1G66-Q100			Unit
			Min	Typ	Max	Min	Typ	Max	
T <sub>amb</sub>	ambient temperature		-40	+25	+125	-40	+25	+125	°C
Δt/ΔV	input transition rise and fall rate	V <sub>CC</sub> = 3.3 ± 0.3 V <sup>[2]</sup>	-	-	100	-	-	-	ns/V
		V <sub>CC</sub> = 5.0 ± 0.5 V <sup>[2]</sup>	-	-	20	-	-	20	ns/V

[1] To avoid drawing V<sub>CC</sub> current from pin Z, when switch-current flows in pin Y, the voltage drop across the bidirectional switch must not exceed 0.4 V. If switch-current flows into pin Z, no V<sub>CC</sub> current flows out of terminal Y. In this case, there is no limit for the voltage drop across the switch. However, the voltage at pins Y and Z may not exceed V<sub>CC</sub> or GND.

[2] Applies to control signal levels.

## 10. Static characteristics

**Table 7. Static characteristics**

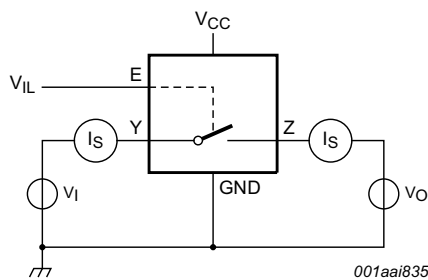
Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
<b>74AHC1G66-Q100</b>										
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.5	-	-	1.5	-	1.5	-	V
		V <sub>CC</sub> = 3.0 V	2.1	-	-	2.1	-	2.1	-	V
		V <sub>CC</sub> = 5.5 V	3.85	-	-	3.85	-	3.85	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	-	0.5	-	0.5	-	0.5	V
		V <sub>CC</sub> = 3.0 V	-	-	0.9	-	0.9	-	0.9	V
		V <sub>CC</sub> = 5.5 V	-	-	1.65	-	1.65	-	1.65	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; V <sub>CC</sub> = 5.5 V	-	-	0.1	-	1.0	-	2.0	μA
I <sub>S(OFF)</sub>	OFF-state leakage current	Y or Z; V <sub>CC</sub> = 5.5 V; see <a href="#">Figure 4</a>	-	-	0.1	-	1.0	-	4.0	μA
I <sub>S(ON)</sub>	ON-state leakage current	Y or Z; V <sub>CC</sub> = 5.5 V; see <a href="#">Figure 5</a>	-	-	0.1	-	1.0	-	4.0	μA
I <sub>CC</sub>	supply current	E, Y or Z = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	-	-	1.0	-	10	-	40	μA
C <sub>I</sub>	input capacitance	E input	-	2.0	10	-	10	-	10	pF
C <sub>S(ON)</sub>	ON-state capacitance	Y or Z input or output	-	4.0	10	-	10	-	10	pF
<b>74AHCT1G66-Q100</b>										
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	-	-	2.0	-	2.0	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	-	-	0.8	-	0.8	-	0.8	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; V <sub>CC</sub> = 5.5 V	-	-	0.1	-	1.0	-	2.0	μA

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

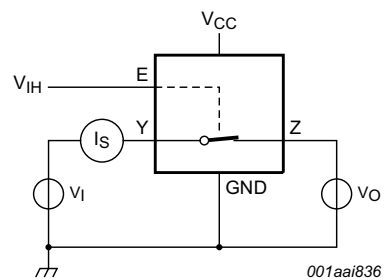
Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$I_{S(OFF)}$	OFF-state leakage current	Y or Z; $V_{CC} = 5.5\text{ V}$ ; see <a href="#">Figure 4</a>	-	-	0.1	-	1.0	-	4.0	$\mu\text{A}$
$I_{S(ON)}$	ON-state leakage current	Y or Z; $V_{CC} = 5.5\text{ V}$ ; see <a href="#">Figure 5</a>	-	-	0.1	-	1.0	-	4.0	$\mu\text{A}$
$I_{CC}$	supply current	E, Y or Z = $V_{CC}$ or GND; $V_{CC} = 5.5\text{ V}$	-	-	1.0	-	10	-	40	$\mu\text{A}$
$\Delta I_{CC}$	additional supply current	per input pin; $V_I = 3.4\text{ V}$ ; other inputs at $V_{CC}$ or GND; $I_O = 0\text{ A}$ ; $V_{CC} = 5.5\text{ V}$	-	-	1.35	-	1.5	-	1.5	mA
$C_I$	input capacitance	E input	-	2.0	10	-	10	-	10	pF
$C_{S(ON)}$	ON-state capacitance	Y or Z input or output	-	4.0	10	-	10	-	10	pF

## 10.1 Test circuits



$V_I = V_{CC}$  or GND and  $V_O = \text{GND}$  or  $V_{CC}$ .

**Fig 4. Test circuit for measuring OFF-state leakage current**



$V_I = V_{CC}$  or GND and  $V_O = \text{open circuit}$ .

**Fig 5. Test circuit for measuring ON-state leakage current**

## 10.2 ON resistance

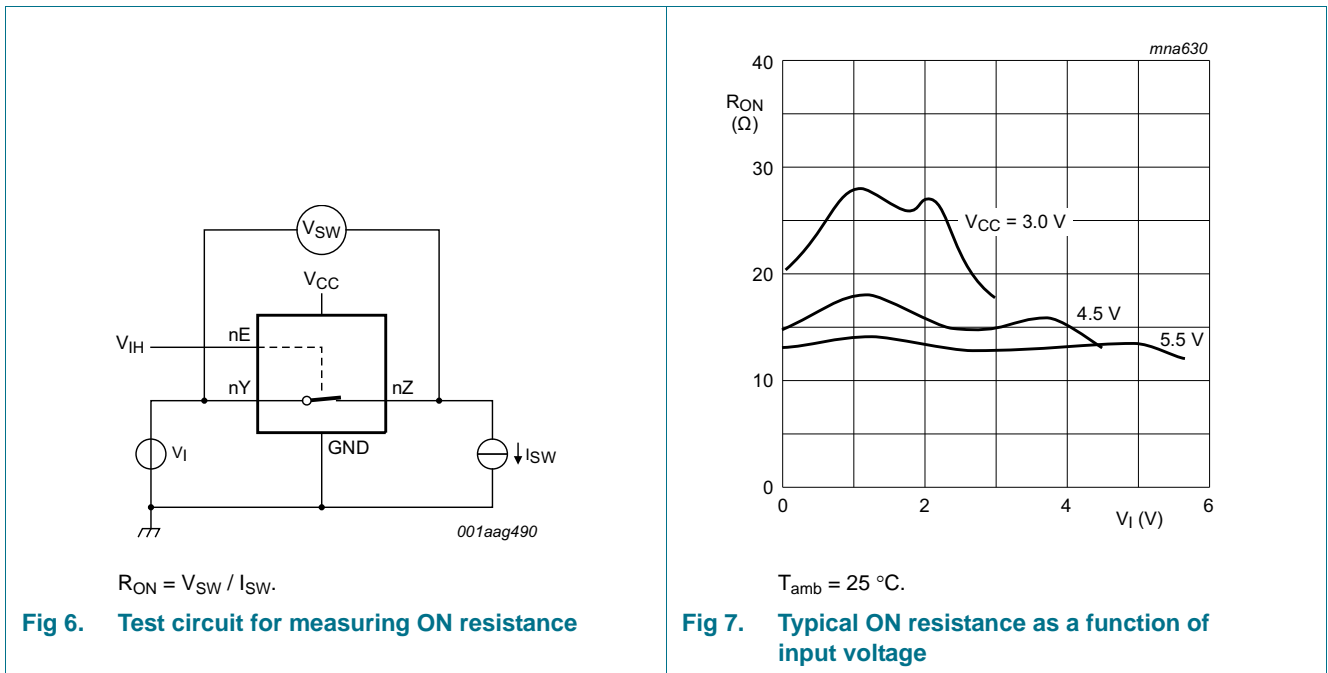
**Table 8. ON resistance**

At recommended operating conditions; voltages are referenced to GND (ground 0 V); for graph see [Figure 7 \[1\]](#).

Symbol	Parameter	Conditions	25 °C		-40 °C to +85 °C	-40 °C to +125 °C	Unit
			Typ	max	Max	Max	
<b>74AHC1G66-Q100 and 74AHCT1G66-Q100</b>							
R <sub>ON(peak)</sub>	ON resistance (peak)	V <sub>I</sub> = V <sub>CC</sub> to GND; see <a href="#">Figure 6</a>					
		I <sub>SW</sub> = 1.0 mA; V <sub>CC</sub> = 2.0 V	148[1]	-	-	-	Ω
		I <sub>SW</sub> = 10 mA; V <sub>CC</sub> = 3.0 V to 3.6 V	28	50	70	110	Ω
		I <sub>SW</sub> = 10 mA; V <sub>CC</sub> = 4.5 V to 5.5 V	15	30	40	60	Ω
R <sub>ON(rail)</sub>	ON resistance (rail)	V <sub>I</sub> = GND; see <a href="#">Figure 6</a>					
		I <sub>SW</sub> = 1.0 mA; V <sub>CC</sub> = 2.0 V	30	-	-	-	Ω
		I <sub>SW</sub> = 10 mA; V <sub>CC</sub> = 3.0 V to 3.6 V	20	50	65	90	Ω
		I <sub>SW</sub> = 10 mA; V <sub>CC</sub> = 4.5 V to 5.5 V	15	22	26	40	Ω
		V <sub>I</sub> = V <sub>CC</sub> ; see <a href="#">Figure 6</a>					
		I <sub>SW</sub> = 1.0 mA; V <sub>CC</sub> = 2.0 V	28	-	-	-	Ω
		I <sub>SW</sub> = 10 mA; V <sub>CC</sub> = 3.0 V to 3.6 V	18	50	65	90	Ω
		I <sub>SW</sub> = 10 mA; V <sub>CC</sub> = 4.5 V to 5.5 V	13	22	26	40	Ω

[1] At supply voltages approaching 2 V, the analog switch ON resistance becomes extremely non-linear. Therefore it is recommended that these devices be used to transmit digital signals only, when using this supply voltage.

## 10.3 ON resistance test circuit and graphs



## 11. Dynamic characteristics

**Table 9. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50$  pF; unless otherwise specified; For test circuit, see [Figure 10](#).

Symbol	Parameter	Conditions	25 °C		-40 °C to +85 °C	-40 °C to +125 °C	Unit
			Typ <sup>[1]</sup>	max	Max	Max	
<b>74AHC1G66-Q100</b>							
$t_{pd}$	propagation delay	Y to Z or Z to Y; see <a href="#">Figure 8</a> <sup>[2]</sup>					
		$V_{CC} = 2.0$ V	2.2	5.0	6.0	7.0	ns
		$V_{CC} = 3.0$ V to 3.6 V	1.0	2.0	3.0	4.0	ns
		$V_{CC} = 4.5$ V to 5.5 V	0.6	1.0	2.0	3.0	ns
$t_{en}$	enable time	E to Y or Z; see <a href="#">Figure 9</a> <sup>[2]</sup>					
		$V_{CC} = 2.0$ V; $C_L = 15$ pF	7.0	25.0	33.0	40.0	ns
		$V_{CC} = 2.0$ V	11.0	35.0	46.0	57.0	ns
		$V_{CC} = 3.0$ V to 3.6 V; $C_L = 15$ pF	4.0	11.0	14.0	18.0	ns
		$V_{CC} = 3.0$ V to 3.6 V	5.8	15.0	20.0	25.0	ns
		$V_{CC} = 4.5$ V to 5.5 V; $C_L = 15$ pF	3.0	8.0	10.0	13.0	ns
		$V_{CC} = 4.5$ V to 5.5 V	4.0	11.0	13.0	17.0	ns
$t_{dis}$	disable time	E to Y or Z; see <a href="#">Figure 9</a> <sup>[2]</sup>					
		$V_{CC} = 2.0$ V; $C_L = 15$ pF	9.0	25.0	33.0	40.0	ns
		$V_{CC} = 2.0$ V	13.0	35.0	46.0	57.0	ns
		$V_{CC} = 3.0$ V to 3.6 V; $C_L = 15$ pF	6.0	11.0	14.0	18.0	ns
		$V_{CC} = 3.0$ V to 3.6 V	8.4	15.0	20.0	25.0	ns
		$V_{CC} = 4.5$ V to 5.5 V; $C_L = 15$ pF	5.0	8.0	10.0	13.0	ns
		$V_{CC} = 4.5$ V to 5.5 V	6.1	11.0	13.0	17.0	ns
$C_{PD}$	power dissipation capacitance	$V_I = \text{GND to } V_{CC}$ <sup>[3]</sup>	13	-	-	-	pF
<b>74AHCT1G66-Q100</b>							
$t_{pd}$	propagation delay	Y to Z or Z to Y; see <a href="#">Figure 8</a> <sup>[2]</sup>					
		$V_{CC} = 4.5$ V to 5.5 V	0.7	1.0	2.0	3.0	ns
$t_{en}$	enable time	E to Y or Z; see <a href="#">Figure 9</a> <sup>[2]</sup>					
		$V_{CC} = 4.5$ V to 5.5 V; $C_L = 15$ pF	3.0	7.0	10.0	13.0	ns
		$V_{CC} = 4.5$ V to 5.5 V	4.7	10.0	13.0	17.0	ns
$t_{dis}$	disable time	E to Y or Z; see <a href="#">Figure 9</a> <sup>[2]</sup>					
		$V_{CC} = 4.5$ V to 5.5 V; $C_L = 15$ pF	5.0	8.0	10.0	13.0	ns
		$V_{CC} = 4.5$ V to 5.5 V	6.5	11.0	13.0	17.0	ns

**Table 9. Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50 \text{ pF}$ ; unless otherwise specified; For test circuit, see [Figure 10](#).

Symbol	Parameter	Conditions	25 °C		-40 °C to +85 °C	-40 °C to +125 °C	Unit
			Typ <sup>[1]</sup>	max	Max	Max	
$C_{PD}$	power dissipation capacitance	$V_I = \text{GND to } V_{CC}$	15	-	-	-	pF

[1] All typical values are measured at  $V_{CC} = 2.0 \text{ V}$ ,  $V_{CC} = 3.3 \text{ V}$ ,  $V_{CC} = 5.0 \text{ V}$  and  $T_{amb} = 25 \text{ °C}$ .

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

$t_{en}$  is the same as  $t_{PZL}$  and  $t_{PZH}$ .

$t_{dis}$  is the same as  $t_{PLZ}$  and  $t_{PHZ}$ .

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

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

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

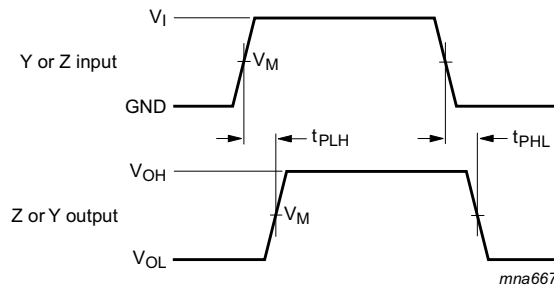
$C_L$  = output load capacitance in pF;

$C_{SW}$  = maximum switch capacitance in pF (see [Table 7](#));

$V_{CC}$  = supply voltage in Volt;

$\sum ((C_L \times C_{SW}) \times V_{CC}^2 \times f_o)$  = sum of outputs.

## 11.1 Waveforms and test circuit

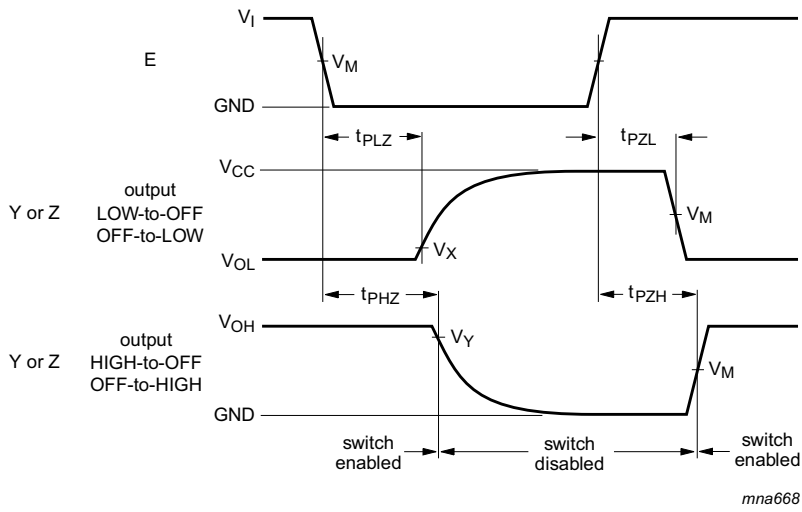


Measurement points are given in [Table 10](#).

Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 8. Input (Y or Z) to output (Z or Y) propagation delays**





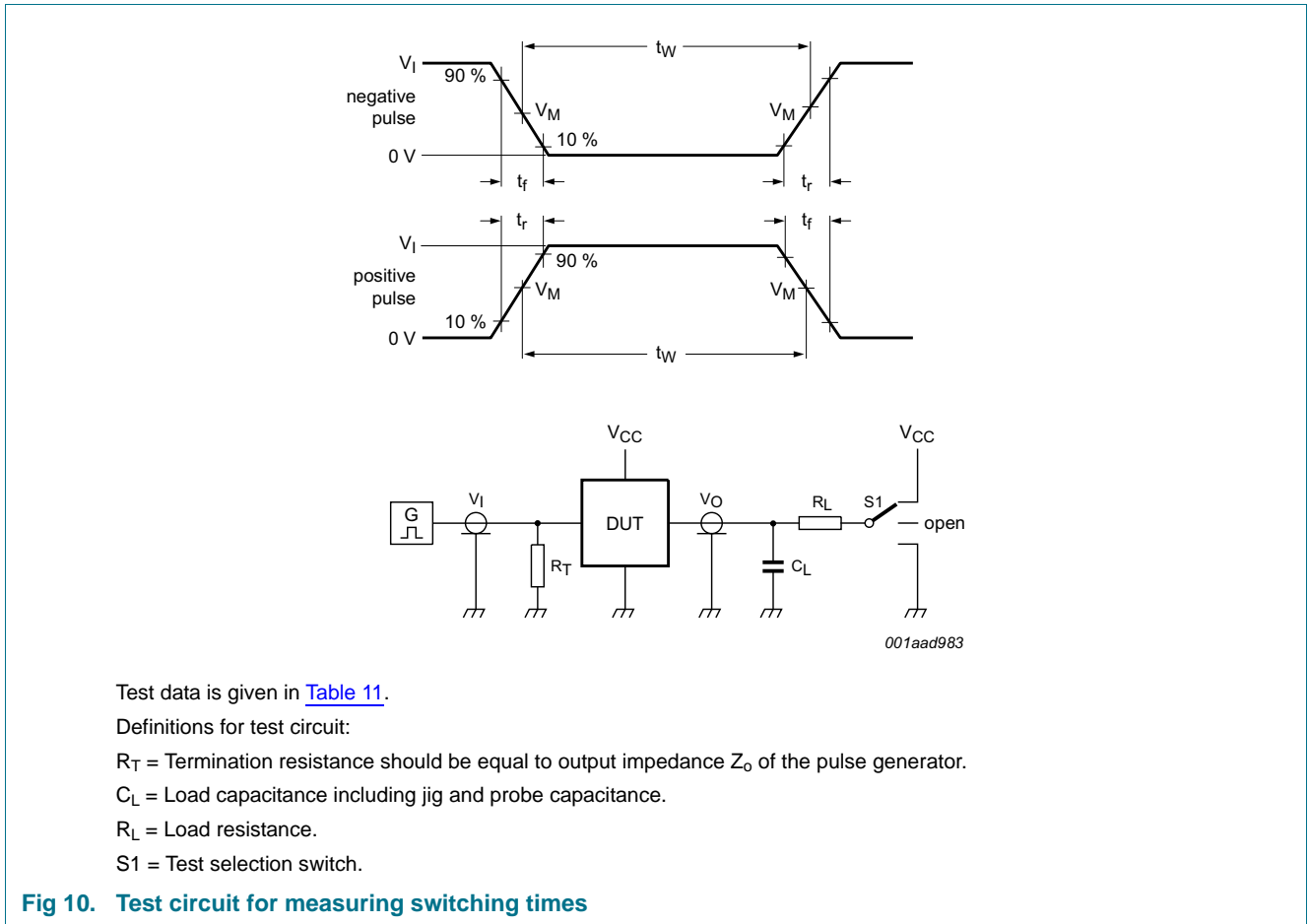
Measurement points are given in [Table 10](#).

Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 9. Enable and disable times**

**Table 10. Measurement points**

Type	Input	Output		
	$V_M$	$V_M$	$V_X$	$V_Y$
74AHC1G66-Q100	$0.5V_{CC}$	$0.5V_{CC}$	$V_{OL} + 0.3 V$	$V_{OH} - 0.3 V$
74AHCT1G66-Q100	1.5 V	1.5 V	$V_{OL} + 0.3 V$	$V_{OH} - 0.3 V$



**Table 11. Test data**

Type	Input		Load		S1 position		
	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PHL}, t_{PLH}$	$t_{PZH}, t_{PHZ}$	$t_{PZL}, t_{PLZ}$
74AHC1G66-Q100	GND to $V_{CC}$	3 ns	15 pF, 50 pF	1 k $\Omega$	open	GND	$V_{CC}$
74AHCT1G66-Q100	GND to 3 V	3 ns	15 pF, 50 pF	1 k $\Omega$	open	GND	$V_{CC}$

## 11.2 Additional dynamic characteristics

**Table 12. Additional dynamic characteristics for 74AHC1G66-Q100 and 74AHCT1G66-Q100**

$GND = 0 V$ ;  $t_r = t_f = 3.0 ns$ ;  $C_L = 50 pF$ ; unless otherwise specified. All typical values are measured at  $T_{amb} = 25 ^\circ C$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
THD	total harmonic distortion	$f_i = 1 kHz$ ; $R_L = 10 k\Omega$ ; see <a href="#">Figure 11</a>					
		$V_{CC} = 3.0 V$ to $3.6 V$	-	0.025	-	%	
		$V_{CC} = 4.5 V$ to $5.5 V$	-	0.015	-	%	
		$f_i = 10 kHz$ ; $R_L = 10 k\Omega$ ; see <a href="#">Figure 11</a>					
		$V_{CC} = 3.0 V$ to $3.6 V$ ; $V_I = 2.5 V$	-	0.025	-	%	
		$V_{CC} = 4.5 V$ to $5.5 V$ ; $V_I = 4.0 V$	-	0.015	-	%	

**Table 12. Additional dynamic characteristics for 74AHC1G66-Q100 and 74AHCT1G66-Q100 ...continued**  
*GND = 0 V;  $t_r = t_f = 3.0$  ns;  $C_L = 50$  pF; unless otherwise specified. All typical values are measured at  $T_{amb} = 25$  °C.*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{(-3dB)}$	-3 dB frequency response	$R_L = 50 \Omega$ ; $C_L = 10$ pF; see <a href="#">Figure 12</a> and <a href="#">13</a>				
		$V_{CC} = 3.0$ V to $3.6$ V	-	230	-	MHz
		$V_{CC} = 4.5$ V to $5.5$ V	-	280	-	MHz
$\alpha_{iso}$	isolation (OFF-state)	$R_L = 600 \Omega$ ; $f_i = 1$ MHz; see <a href="#">Figure 14</a> <a href="#">[1]</a>				
		$V_{CC} = 3.0$ V to $3.6$ V; $V_I = 2.5$ V	-	-50	-	dB
		$V_{CC} = 4.5$ V to $5.5$ V; $V_I = 4.0$ V	-	-50	-	dB

[1] Adjust input voltage  $V_I$  to 0 dBm level (0 dBm = 1 mW into 50  $\Omega$ ).

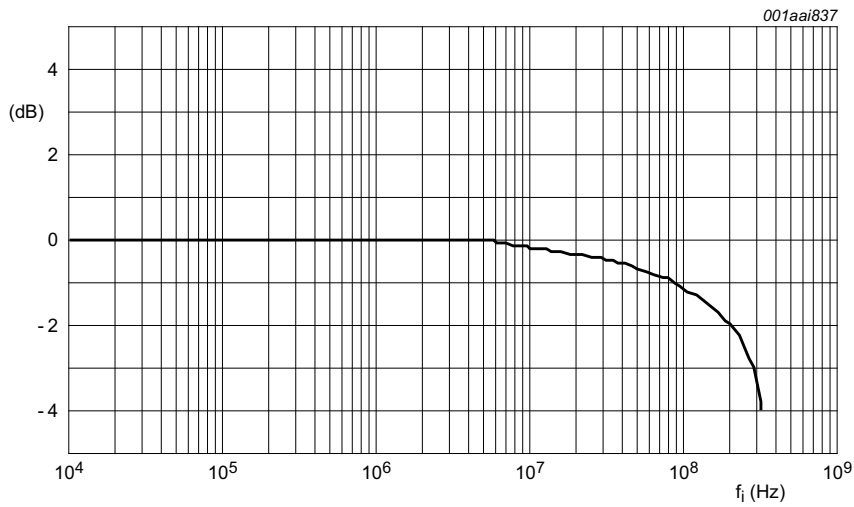
### 11.3 Test circuits and graphs

**Test conditions:**  
 $V_{CC} = 3.0$  V to  $3.6$  V;  $V_I = 2.5$  V (p-p).  
 $V_{CC} = 4.5$  V to  $5.5$  V;  $V_I = 4.0$  V (p-p).

**Fig 11. Test circuit for measuring total harmonic distortion**

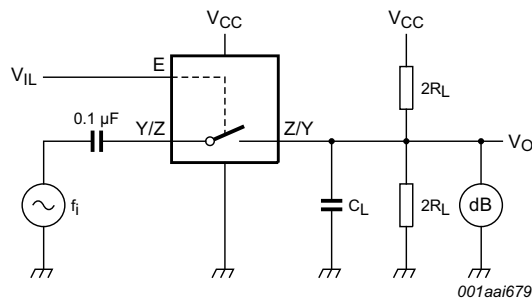
With  $f_i = 1$  MHz, adjust the switch input voltage for a 0 dBm level at the switch output (0 dBm = 1 mW into 50  $\Omega$ ). Then increase the input  $f_i$  frequency until the dB meter reads -3 dB.

**Fig 12. Test circuit for measuring the -3 dB frequency response**



Test conditions:  $V_{CC} = 4.5\text{ V}$ ;  $GND = 0\text{ V}$ ;  $R_L = 50\ \Omega$ ;  $R_{SOURCE} = 1\text{ k}\Omega$ .

**Fig 13. Typical -3 dB frequency response**



Adjust the switch input voltage for a 0 dBm level (0 dBm = 1 mW into 600  $\Omega$ ).

**Fig 14. Test circuit for measuring isolation (OFF-state)**

## 12. Package outline

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

SOT353-1

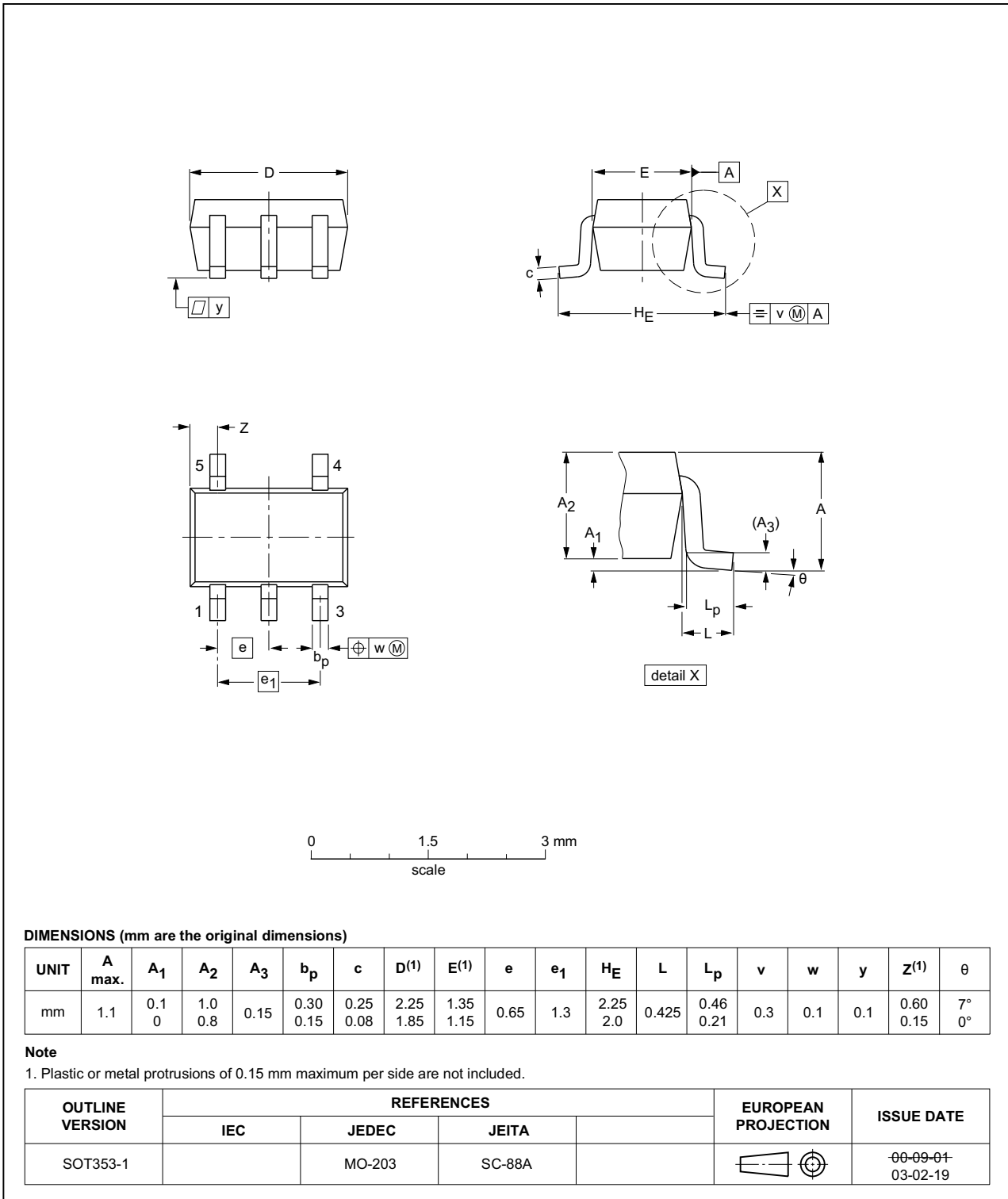


Fig 15. Package outline SOT353-1 (TSSOP5)

Plastic surface-mounted package; 5 leads

SOT753

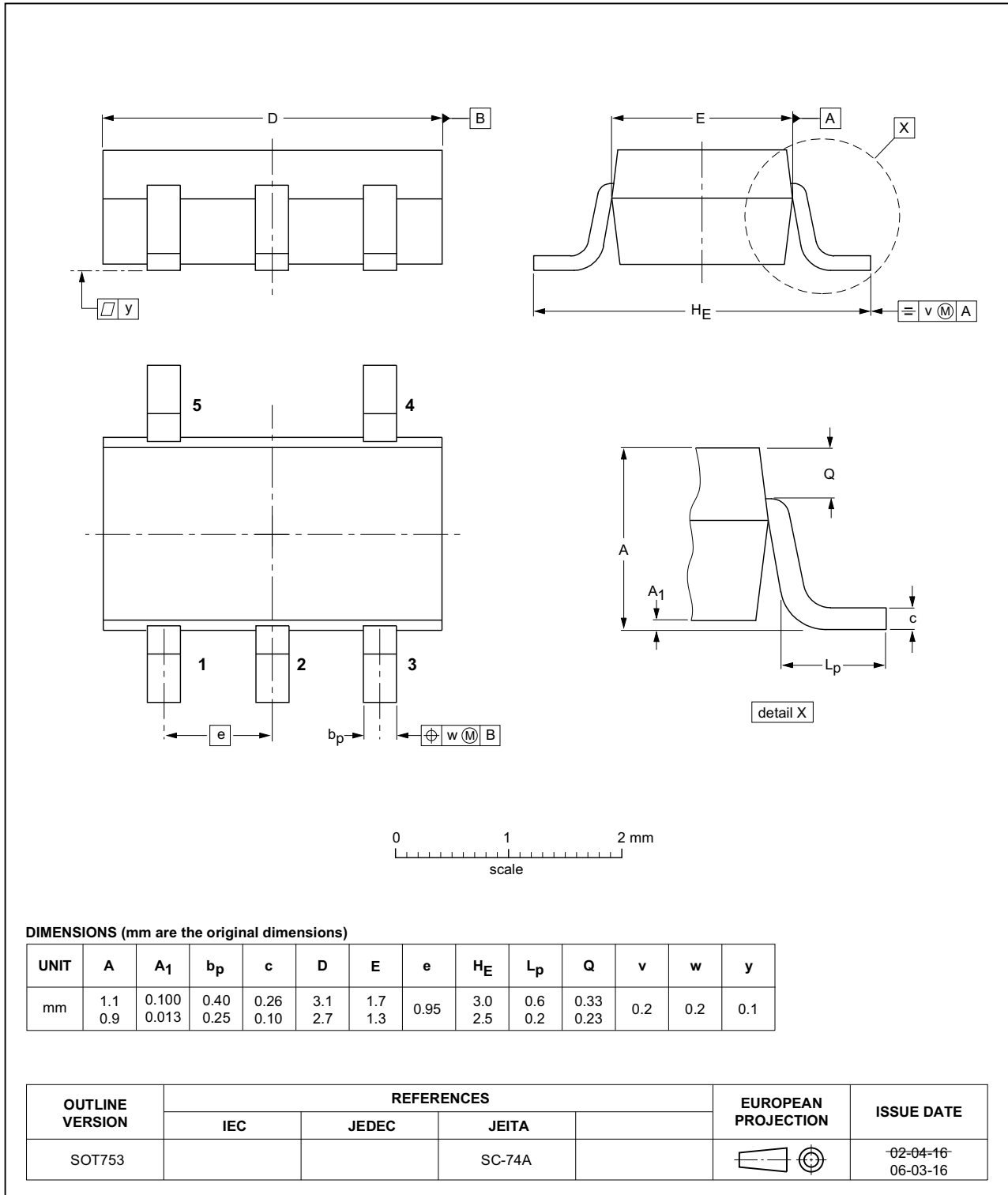


Fig 16. Package outline SOT753 (SC-74A)

## 13. Abbreviations

Table 13. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model

## 14. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74AHC_AHCT1G66_Q100 v.1	20150127	Product data sheet	-	-

## 15. Legal information

### 15.1 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.
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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