

# 74AVC16374-Q100

16-bit edge triggered D-type flip-flop; 3.6 V tolerant; 3-state

Rev. 1 — 16 September 2013

Product data sheet

## 1. General description

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The 74AVC16374-Q100 is a 16-bit edge triggered flip-flop featuring separate D-type inputs for each flip-flop and 3-state outputs for bus-oriented applications. The 74AVC16374-Q100 consist of 2 sections of 8 edge-triggered flip-flops. A clock input (CP) and an output enable ( $\overline{OE}$ ) are provided per 8-bit section.

The 74AVC16374-Q100 is designed to have an extremely fast propagation delay and a minimum amount of power consumption.

To ensure the high-impedance output state during power-up or power-down,  $\overline{nOE}$  should be tied to VCC through a pull-up resistor (Live Insertion).

A Dynamic Controlled Output (DCO) circuitry is implemented to support termination line drive during transient (see [Figure 5](#) and [Figure 6](#)).

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 3) and is suitable for use in automotive applications.

## 2. Features and benefits

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- Automotive product qualification in accordance with AEC-Q100 (Grade 3)
  - ◆ Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- Wide supply voltage range from 1.2 V to 3.6 V
- Complies with JEDEC standards:
  - ◆ JESD8-7 (1.2 V to 1.95 V)
  - ◆ JESD8-5 (1.8 V to 2.7 V)
  - ◆ JESD8-1A (2.7 V to 3.6 V)
- 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 pF, R = 0  $\Omega$ )
- CMOS low power consumption
- Input/output tolerant up to 3.6 V
- Dynamic Controlled Output (DCO) circuit dynamically changes output impedance, resulting in noise reduction without speed degradation
- Low inductance multiple V<sub>CC</sub> and GND pins to minimize noise and ground bounce
- Supports Live Insertion



### 3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74AVC16374DGG-Q100	-40 °C to +85 °C	TSSOP48	plastic thin shrink small outline package; 48 leads; body width 6.1 mm	SOT362-1

### 4. Functional diagram

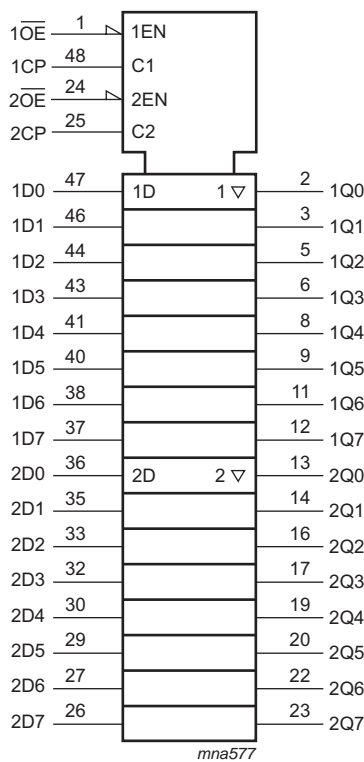


Fig 1. IEC logic symbol

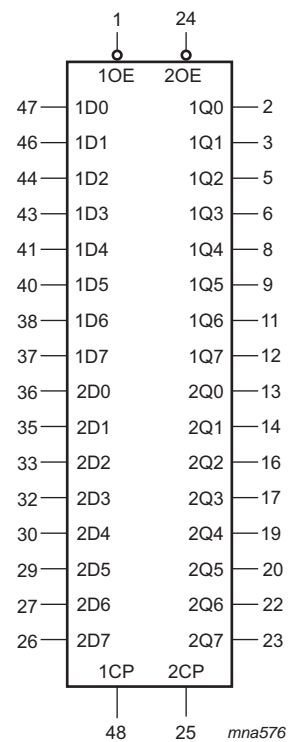


Fig 2. Logic symbol

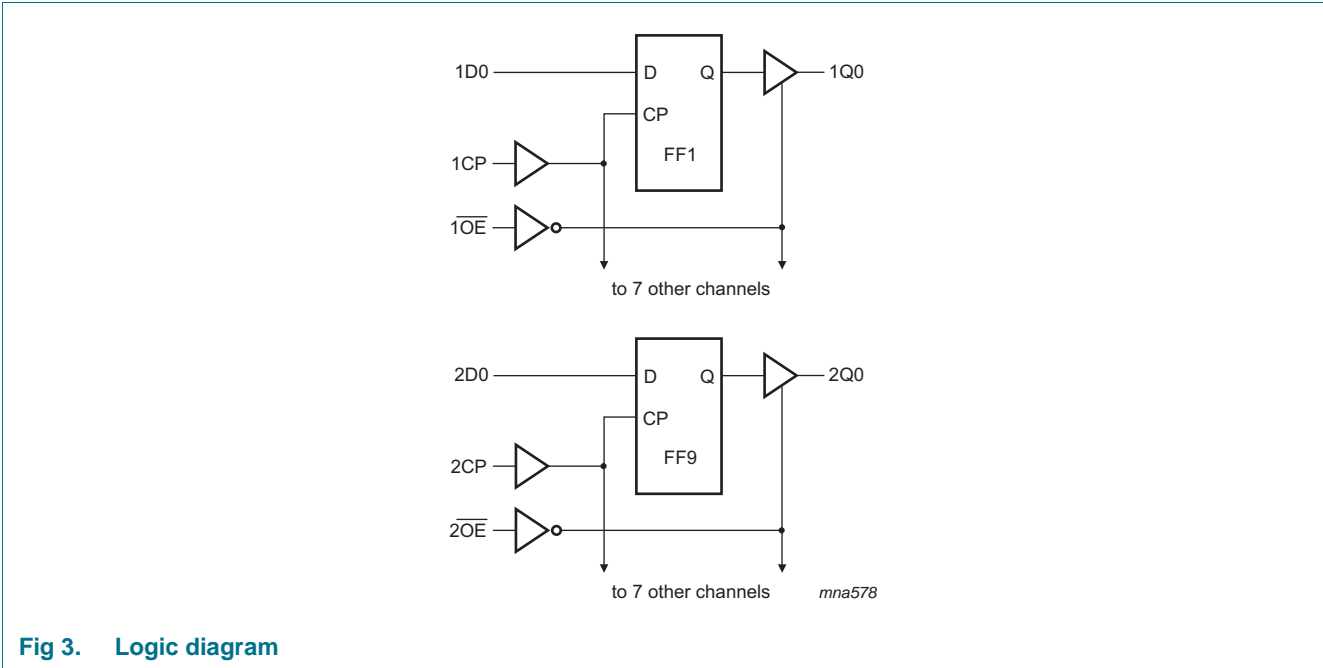


Fig 3. Logic diagram

## 5. Pinning information

### 5.1 Pinning

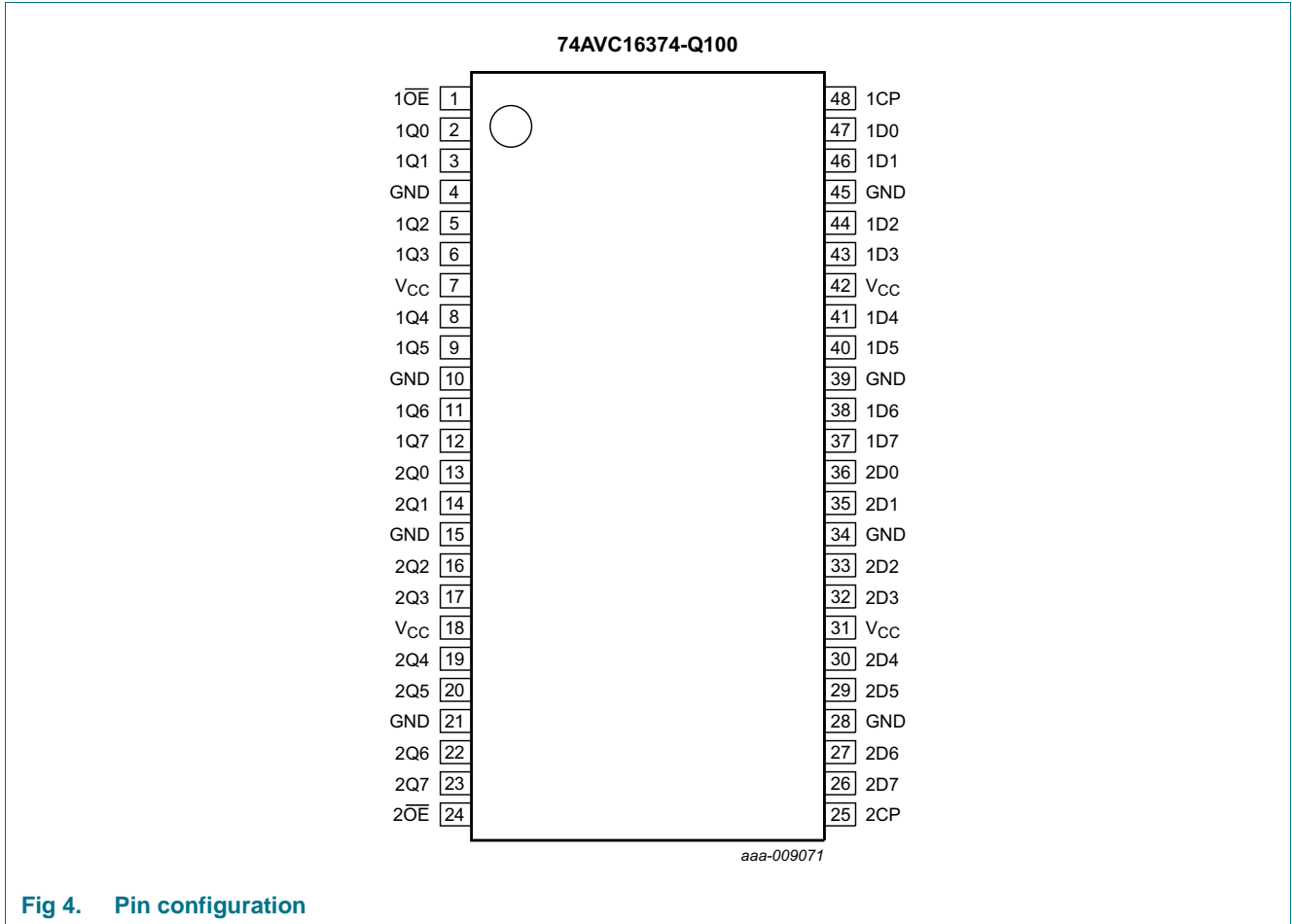


Fig 4. Pin configuration

### 5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1OE	1	output enable input (active LOW)
1Q0 to 1Q7	2, 3, 5, 6, 8, 9, 11, 12	3-state flip-flop outputs
GND	4, 10, 15, 21, 28, 34, 39, 45	ground (0 V)
V <sub>CC</sub>	7, 18, 31, 42	supply voltage
2Q0 to 2Q7	13, 14, 16, 17, 19, 20, 22, 23	3-state flip-flop outputs
2OE	24	output enable input (active LOW)
2CP	25	clock input
2D0 to 2D7	36, 35, 33, 32, 30, 29, 27, 26	data input/output
1D0 to 1D7	47, 46, 44, 43, 41, 40, 38, 37	data input/output
1CP	48	clock input

## 6. Functional description

Table 3. Function table<sup>[1]</sup>

Operating modes	Inputs			Internal flip-flops	Outputs nQn
	nOE	nCp	nDn		
Load and read register	L	↑	l	L	L
	L	↑	h	H	H
Load register and disable outputs	H	↑	l	L	Z
	H	↑	h	H	Z

- [1] H = HIGH voltage level  
 h = HIGH voltage level one set-up time prior to the LOW-to-HIGH CP transition  
 L = LOW voltage level  
 l = LOW voltage level one set-up time prior to the LOW-to-HIGH CP transition  
 Z = high-impedance OFF-state  
 ↑ = LOW-to-HIGH CP transition

## 7. Limiting values

Table 4. 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
$V_{CC}$	supply voltage		-0.5	+4.6	V
$I_{IK}$	input clamping current	$V_I < 0$ V	-	-50	mA
$V_I$	input voltage		[1] -0.5	+4.6	V
$I_{OK}$	output clamping current	$V_O < 0$ V	-50	-	mA
$V_O$	output voltage	output HIGH or LOW	[1] -0.5	$V_{CC} + 0.5$	V
		output 3-state	[1] -0.5	+4.6	V
$I_O$	output current	$V_O = 0$ V to $V_{CC}$	-	±50	mA
$I_{CC}$	supply current		-	+100	mA
$I_{GND}$	ground current		-100	-	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +85 °C	[2] -	500	mW

- [1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.  
 [2] Above 60 °C, the value of  $P_{tot}$  derates linearly with 5.5 mW/K.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>CC</sub>	supply voltage	according to JEDEC Low Voltage Standards	1.4	-	1.6	V
			1.65	-	1.95	V
			2.3	-	2.7	V
			3.0	-	3.6	V
		for low-voltage applications	1.2	-	3.6	V
V <sub>I</sub>	input voltage		0	-	3.6	V
V <sub>O</sub>	output voltage	output HIGH or LOW	0	-	V <sub>CC</sub>	V
		output 3-state	0	-	3.6	V
T <sub>amb</sub>	ambient temperature	in free air	-40	-	+85	°C
Δt/ΔV	input transition rise and fall rate	V <sub>CC</sub> = 1.4 V to 1.6 V	0	-	40	ns/V
		V <sub>CC</sub> = 1.65 V to 2.3 V	0	-	30	ns/V
		V <sub>CC</sub> = 2.3 V to 3.0 V	0	-	20	ns/V
		V <sub>CC</sub> = 3.0 V to 3.6 V	0	-	10	ns/V

## 9. Static characteristics

**Table 6. Static characteristics**

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Typ <sup>[1]</sup>	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +85 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 1.2 V	V <sub>CC</sub>	-	-	V
		V <sub>CC</sub> = 1.4 V to 1.6 V	0.65 × V <sub>CC</sub>	0.9	-	V
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 × V <sub>CC</sub>	0.9	-	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.7	1.2	-	V
		V <sub>CC</sub> = 3.0 V to 3.6 V	2.0	1.5	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 1.2 V	-	-	GND	V
		V <sub>CC</sub> = 1.4 V to 1.6 V	-	0.9	0.35 × V <sub>CC</sub>	V
		V <sub>CC</sub> = 1.65 V to 1.95 V	-	0.9	0.35 × V <sub>CC</sub>	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	1.2	0.7	V
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	1.5	0.8	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = -100 μA; V <sub>CC</sub> = 1.65 V to 3.6 V	V <sub>CC</sub> - 0.20	V <sub>CC</sub>	-	V
		I <sub>O</sub> = -3 mA; V <sub>CC</sub> = 1.4 V	V <sub>CC</sub> - 0.35	V <sub>CC</sub> - 0.23	-	V
		I <sub>O</sub> = -4 mA; V <sub>CC</sub> = 1.65 V	V <sub>CC</sub> - 0.45	V <sub>CC</sub> - 0.25	-	V
		I <sub>O</sub> = -8 mA; V <sub>CC</sub> = 2.3 V	V <sub>CC</sub> - 0.55	V <sub>CC</sub> - 0.38	-	V
		I <sub>O</sub> = -12 mA; V <sub>CC</sub> = 3.0 V	V <sub>CC</sub> - 0.70	V <sub>CC</sub> - 0.48	-	V

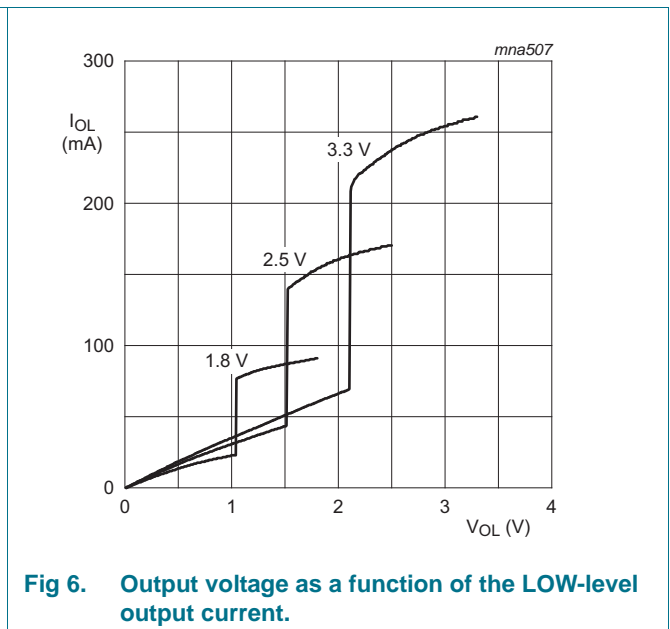
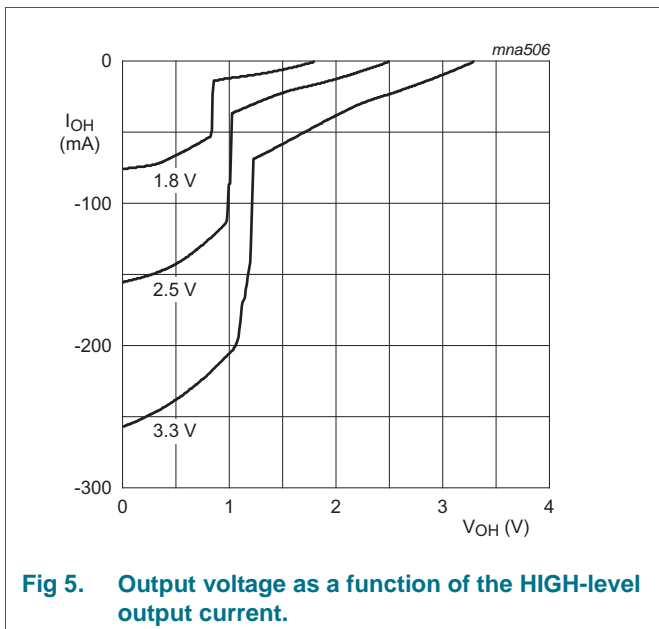
**Table 6. Static characteristics ...continued**

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Typ <sup>[1]</sup>	Max	Unit
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 1.65 V to 3.6 V	-	GND	0.20	V
		I <sub>O</sub> = 3 mA; V <sub>CC</sub> = 1.4 V	-	0.10	0.35	V
		I <sub>O</sub> = 4 mA; V <sub>CC</sub> = 1.65 V	-	0.10	0.45	V
		I <sub>O</sub> = 8 mA; V <sub>CC</sub> = 2.3 V	-	0.26	0.55	V
		I <sub>O</sub> = 12 mA; V <sub>CC</sub> = 3.0 V	-	0.36	0.70	V
I <sub>I</sub>	input leakage current	per pin; V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 1.4 V to 3.6 V	-	0.1	2.5	μA
I <sub>OFF</sub>	power-off leakage current	V <sub>I</sub> or V <sub>O</sub> = 3.6 V; V <sub>CC</sub> = 0.0 V	-	±0.1	±10	μA
I <sub>OZ</sub>	OFF-state output current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = V <sub>CC</sub> or GND				
		V <sub>CC</sub> = 1.4 V to 2.7 V	-	0.1	5	μA
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	0.1	10	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> = 1.4 V to 2.7 V	-	0.1	20	μA
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	0.2	40	μA
C <sub>I</sub>	input capacitance		-	5	-	pF

[1] All typical values are measured at T<sub>amb</sub> = 25 °C.

### 9.1 Graphs



## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V).  $t_r = t_f \leq 2$  ns. For test circuit, see [Figure 10](#).

Symbol	Parameter	Conditions	-40 °C to +85 °C			Unit
			Min	Typ <sup>[2]</sup>	Max	
t <sub>pd</sub>	propagation delay	nCP to nQn; see <a href="#">Figure 7</a> <sup>[1]</sup>				
		V <sub>CC</sub> = 1.2 V	-	3.1	-	ns
		V <sub>CC</sub> = 1.4 V to 1.6 V	1.2	2.4	8.4	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.0	2.0	6.7	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.8	1.5	4.1	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	0.7	1.3	3.3	ns
t <sub>en</sub>	enable time	nOE to nQn, nBn; see <a href="#">Figure 8</a> <sup>[1]</sup>				
		V <sub>CC</sub> = 1.2 V	-	5.4	-	ns
		V <sub>CC</sub> = 1.4 V to 1.6 V	1.6	3.9	8.5	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	2.3	3.3	6.7	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.9	2.3	4.3	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	0.7	2.0	3.4	ns
t <sub>dis</sub>	disable time	nOE to nQn; see <a href="#">Figure 8</a> <sup>[1]</sup>				
		V <sub>CC</sub> = 1.2 V	-	5.6	-	ns
		V <sub>CC</sub> = 1.4 V to 1.6 V	2.5	4.5	9.4	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.8	3.3	7.8	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.0	1.8	4.2	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.2	2.0	3.9	ns
t <sub>w</sub>	pulse width	HIGH; nCP; see <a href="#">Figure 7</a>				
		V <sub>CC</sub> = 1.2 V	-	0.8	-	ns
		V <sub>CC</sub> = 1.4 V to 1.6 V	-	0.5	-	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	3.1	0.3	-	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	2.5	0.2	-	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	2.5	0.2	-	ns
t <sub>su</sub>	set-up time	nDn to nCP; see <a href="#">Figure 8</a>				
		V <sub>CC</sub> = 1.2 V	-	-0.6	-	ns
		V <sub>CC</sub> = 1.4 V to 1.6 V	2.7	-0.3	-	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.9	-0.3	-	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.4	-0.2	-	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.4	-0.1	-	ns
t <sub>h</sub>	hold time	nDn to nCP; see <a href="#">Figure 8</a>				
		V <sub>CC</sub> = 1.2 V	-	0.8	-	ns
		V <sub>CC</sub> = 1.4 V to 1.6 V	1.3	0.7	-	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.2	0.6	-	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.1	0.5	-	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.1	0.4	-	ns



**Table 7. Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V).  $t_r = t_f \leq 2$  ns. For test circuit, see [Figure 10](#).

Symbol	Parameter	Conditions	-40 °C to +85 °C			Unit
			Min	Typ <sup>[2]</sup>	Max	
$f_{max}$	maximum frequency	see <a href="#">Figure 8</a>				
		$V_{CC} = 1.2$ V	-	250	-	MHz
		$V_{CC} = 1.4$ V to 1.6 V	-	300	-	MHz
		$V_{CC} = 1.65$ V to 1.95 V	160	320	-	MHz
		$V_{CC} = 2.3$ V to 2.7 V	200	350	-	MHz
		$V_{CC} = 3.0$ V to 3.6 V	200	350	-	MHz
$C_{PD}$	power dissipation capacitance	per input; $V_I = GND$ to $V_{CC}$				
		outputs enabled	-	66	-	pF
		outputs disabled	-	1	-	pF

- [1]  $t_{pd}$  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  $t_{PHZ}$ .

- [2] Typical values are measured at  $T_{amb} = 25$  °C and  $V_{CC} = 1.2$  V, 1.5 V, 1.8 V, 2.5 V and 3.3 V respectively.

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

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

$f_i$  = input frequency in MHz;  $f_o$  = output frequency in MHz

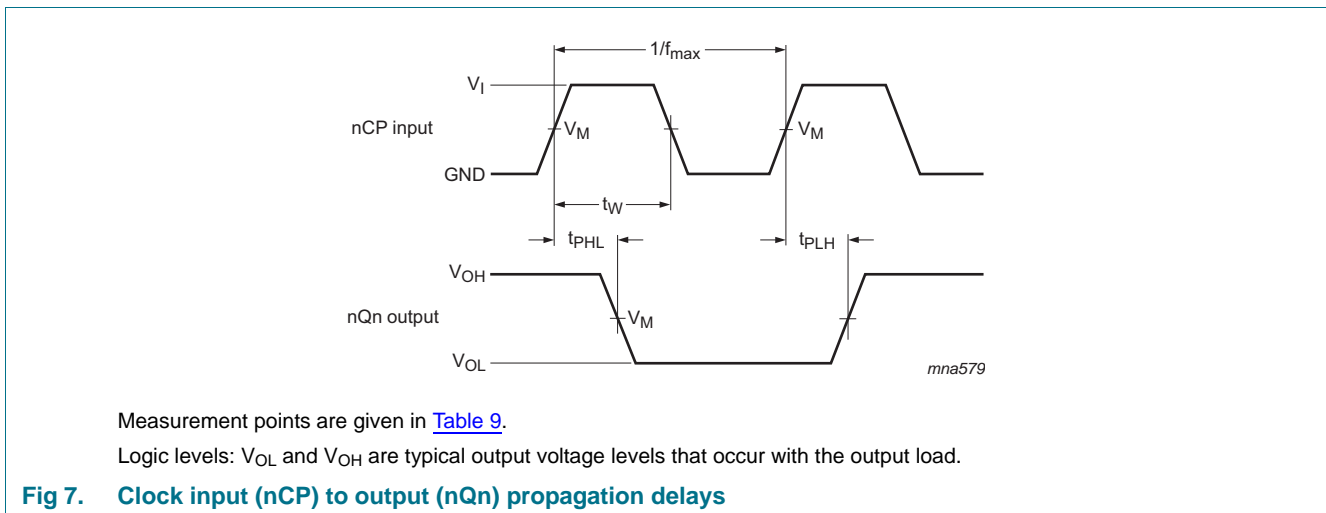
$C_L$  = output load capacitance in pF

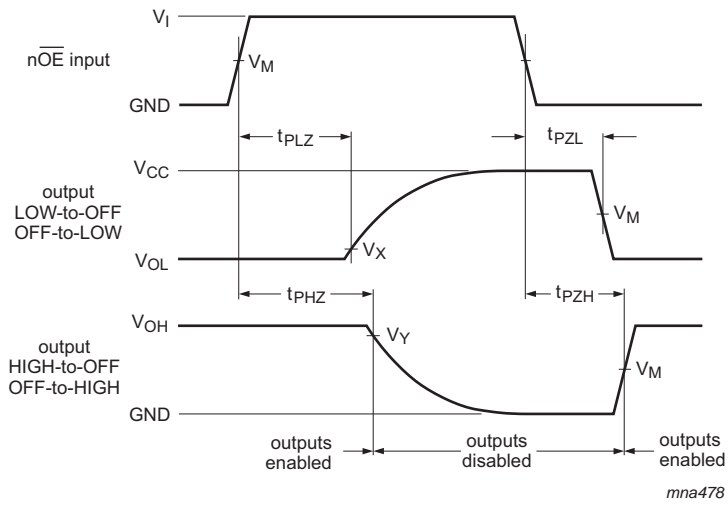
$V_{CC}$  = supply voltage in Volts

$N$  = number of inputs switching

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

## 11. Waveforms

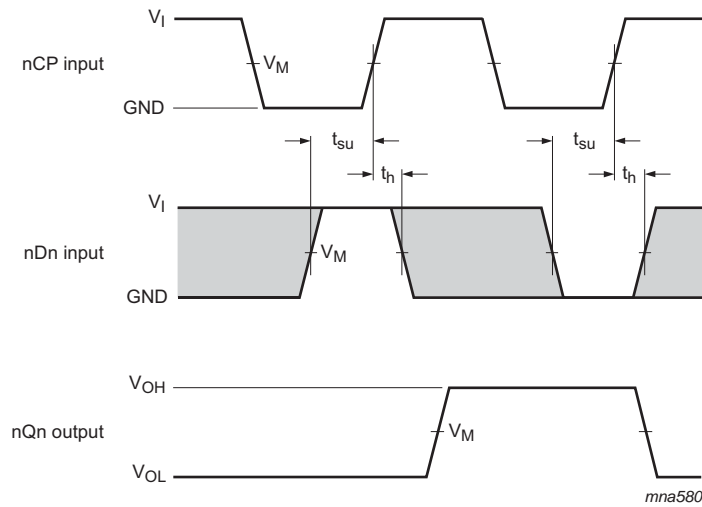




Measurement points are given in [Table 9](#).

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

**Fig 8. 3-state enable and disable times**



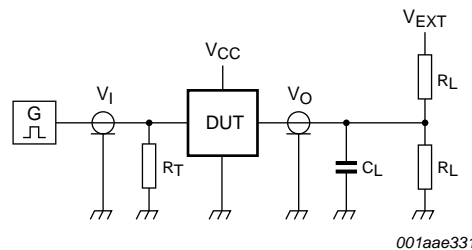
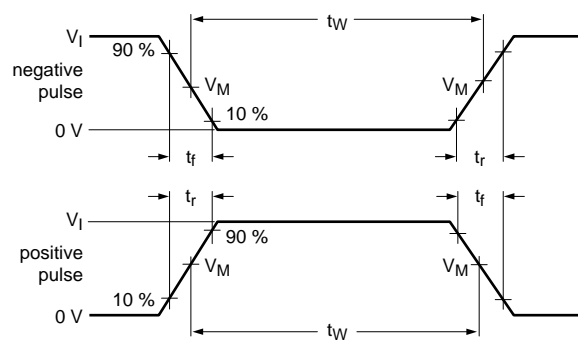
Measurement points are given in [Table 9](#).

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

**Fig 9. Data set-up and hold times for nDn input to nCP input**

Table 8. Measurement points

Supply voltage	$V_M$	Input			
$V_{CC}$		$V_I$	$t_r = t_f$	$V_X$	$V_Y$
1.2 V	$0.5 \times V_{CC}$	$V_{CC}$	$\leq 2$ ns	$V_{OL} + 0.15$ V	$V_{OH} - 0.15$ V
1.4 V to 1.6 V	$0.5 \times V_{CC}$	$V_{CC}$	$\leq 2$ ns	$V_{OL} + 0.15$ V	$V_{OH} - 0.15$ V
1.65 V to 1.95 V	$0.5 \times V_{CC}$	$V_{CC}$	$\leq 2$ ns	$V_{OL} + 0.15$ V	$V_{OH} - 0.15$ V
2.3 V to 2.7 V	$0.5 \times V_{CC}$	$V_{CC}$	$\leq 2$ ns	$V_{OL} + 0.15$ V	$V_{OH} - 0.15$ V
3.0 V to 3.6 V	$0.5 \times V_{CC}$	$V_{CC}$	$\leq 2$ ns	$V_{OL} + 0.3$ V	$V_{OH} - 0.3$ V



001aae331

Test data is given in [Table 9](#).

Definitions for test circuit:

$R_L$  = Load resistance.

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

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

$V_{EXT}$  = External voltage for measuring switching times.

Fig 10. Test circuit for measuring switching times

Table 9. Test data

Supply voltage	Input		Load		$V_{EXT}$		
	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PLH}, t_{PHL}$	$t_{PLZ}, t_{PZL}$	$t_{PHZ}, t_{PZH}$
1.2 V	$V_{CC}$	$\leq 2$ ns	15 pF	2 k $\Omega$	open	$2 \times V_{CC}$	GND
1.4 V to 1.6 V	$V_{CC}$	$\leq 2$ ns	15 pF	2 k $\Omega$	open	$2 \times V_{CC}$	GND
1.65 V to 1.95 V	$V_{CC}$	$\leq 2$ ns	30 pF	1 k $\Omega$	open	$2 \times V_{CC}$	GND
2.3 V to 2.7 V	$V_{CC}$	$\leq 2$ ns	30 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND
3.0 V to 3.6 V	$V_{CC}$	$\leq 2$ ns	30 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND

12. Package outline

TSSOP48: plastic thin shrink small outline package; 48 leads; body width 6.1 mm

SOT362-1

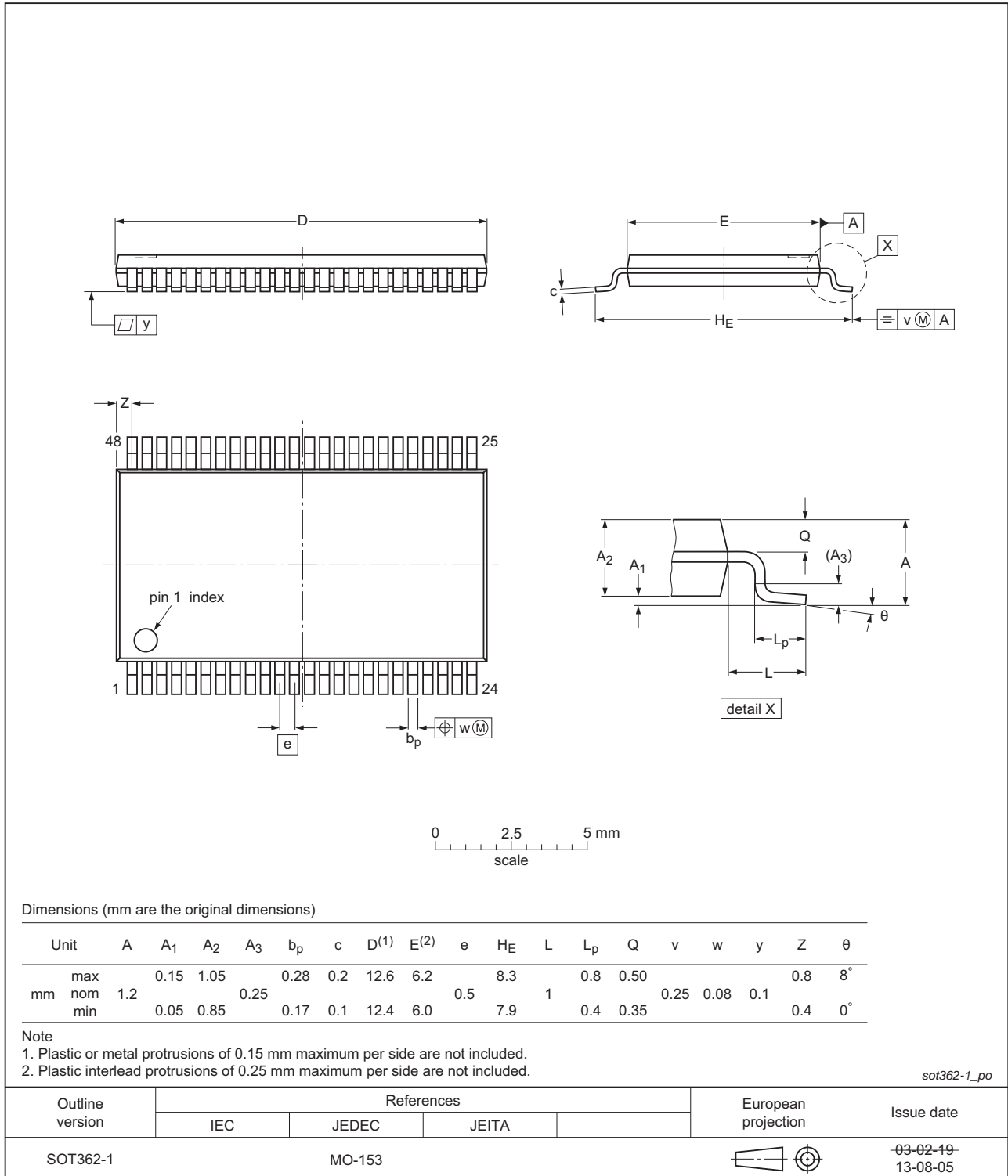


Fig 11. Package outline SOT362-1 (TSSOP48)

## 13. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
MIL	Military
TTL	Transistor-Transistor Logic

## 14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Order number	Supersedes
74AVC16374_Q100 v.1	20130916	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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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