

74LVC377

Octal D-type flip-flop with data enable; positive-edge trigger

Rev. 05 — 21 February 2005

Product data sheet

1. General description

The 74LVC377 is a low-voltage, Si-gate CMOS device superior to most advanced CMOS compatible TTL families.

The 74LVC377 has eight edge-triggered D-type flip-flops with individual inputs (D) and outputs (Q). A common clock input (CP) loads all flip-flops simultaneously when data enable input (\bar{E}) is LOW. The state of each D input, one set-up time before the LOW-to-HIGH clock transition, is transferred to the corresponding output (Qn) of the flip-flop. Input \bar{E} must be stable only one set-up time prior to the LOW-to-HIGH transition for predictable operation.

2. Features

- Wide supply voltage range from 1.2 V to 3.6 V
- Inputs accept voltages up to 5.5 V
- CMOS low power consumption
- Direct interface with TTL levels
- Output drive capability 50 Ω transmission lines at 125 °C
- Complies with JEDEC standard:
 - ◆ JESD8-B/JESD36 (2.7 V to 3.6 V)
- ESD protection:
 - ◆ HBM EIA/JESD22-A114-B exceeds 2000 V
 - ◆ MM EIA/JESD22-A115-A exceeds 200 V
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

3. Quick reference data

Table 1: Quick reference data

$GND = 0 V$; $T_{amb} = 25\text{ °C}$.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{PHL} , t_{PLH}	propagation delay CP to Qn	$V_{CC} = 3.3 V$; $C_L = 50\text{ pF}$; $R_L = 500\ \Omega$	-	4.6	-	ns
C_I	input capacitance		-	5.0	-	pF
f_{max}	maximum clock frequency	$V_{CC} = 3.3 V$	-	330	-	MHz

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Table 1: Quick reference data ...continued

$GND = 0\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}.$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{PD}	power dissipation capacitance per flip-flop		[1][2] -	22	-	pF

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

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

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

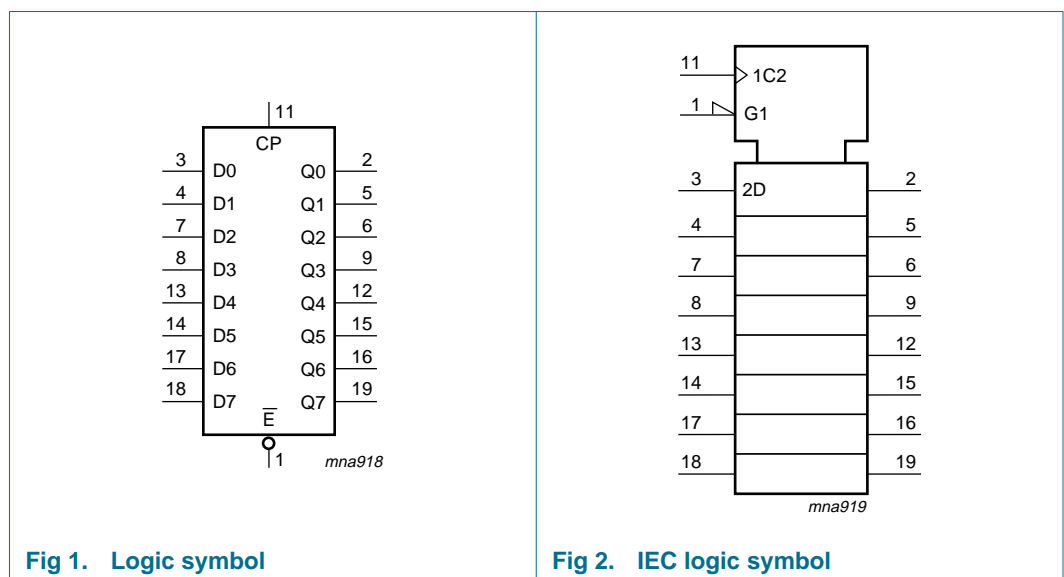
[2] The condition is $V_i = GND$ to V_{CC} .

4. Ordering information

Table 2: Ordering information

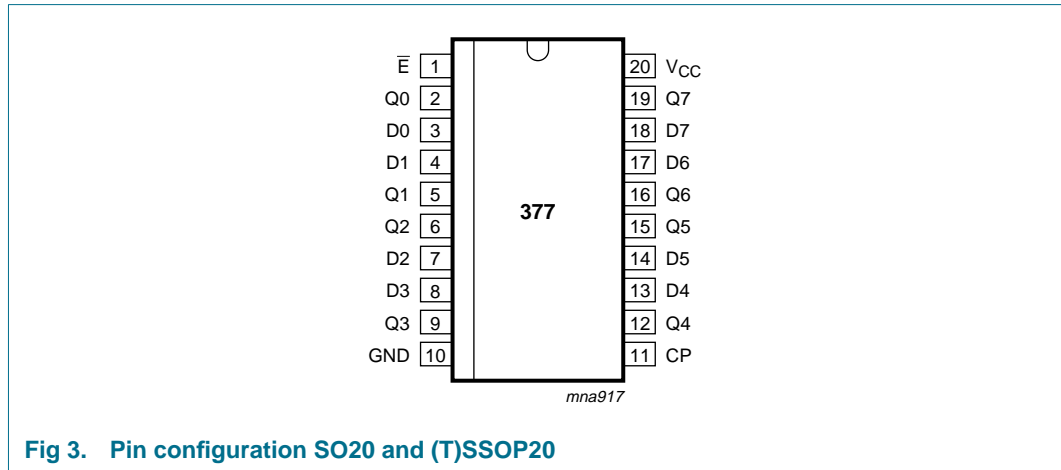
Type number	Package			Version
	Temperature range	Name	Description	
74LVC377D	-40 °C to +125 °C	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1
74LVC377DB	-40 °C to +125 °C	SSOP20	plastic shrink small outline package; 20 leads; body width 5.3 mm	SOT339-1
74LVC377PW	-40 °C to +125 °C	TSSOP20	plastic thin shrink small outline package; 20 leads; body width 4.4 mm	SOT360-1

5. Functional diagram



6. Pinning information

6.1 Pinning



6.2 Pin description

Table 3: Pin description

Symbol	Pin	Description
\bar{E}	1	data enable input (active LOW)
Q0	2	flip-flop output 0
D0	3	data input 0
D1	4	data input 1
Q1	5	flip-flop output 1
Q2	6	flip-flop output 2
D2	7	data input 2
D3	8	data input 3
Q3	9	flip-flop output 3
GND	10	ground (0 V)
CP	11	clock input (LOW-to-HIGH; edge-triggered)
Q4	12	flip-flop output 4
D4	13	data input 4
D5	14	data input 5
Q5	15	flip-flop output 5
Q6	16	flip-flop output 6
D6	17	data input 6
D7	18	data input 7
Q7	19	flip-flop output 7
V _{CC}	20	power supply

7. Functional description

7.1 Function table

Table 4: Function table ^[1]

Operating mode	Control		Input	Output
	CP	\bar{E}	Dn	Qn
Load 1	↑	l	h	H
Load 0	↑	l	l	L
Hold	↑	h	X	no change
Do nothing	X	H	X	no change

- [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;
 ↑ = LOW-to-HIGH CP transition;
 X = don't care.

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_{CC}	supply voltage		-0.5	+6.5	V
V_I	input voltage		^[1] -0.5	+5.5	V
V_O	output voltage		^[1] -0.5	$V_{CC} + 0.5$	V
I_{IK}	input diode current	$V_I < 0$ V	-	-50	mA
I_O	output source or sink current	$V_O = 0$ V to V_{CC}	-	±50	mA
I_{OK}	output diode current	$V_O > V_{CC}$ or $V_O < 0$ V	-	±50	mA
I_{CC} , I_{GND}	V_{CC} or GND current		-	±100	mA
T_{stg}	storage temperature		-65	+150	°C
P_{tot}	total power dissipation	$T_{amb} = -40$ °C to +125 °C ^[2]	-	500	mW

- [1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
 [2] For SO20 packages: above 70 °C derate linearly with 8 mW/K.
 For (T)SSOP20 packages: above 60 °C derate linearly with 5.5 mW/K.

9. Recommended operating conditions

Table 6: Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage	maximum speed performance	2.7	-	3.6	V
		low-voltage applications	1.2	-	3.6	V
V_I	input voltage		0	-	5.5	V
V_O	output voltage		0	-	V_{CC}	V
T_{amb}	ambient temperature	in free air	-40	-	+125	°C
t_r, t_f	input rise and fall times	$V_{CC} = 1.2\text{ V to } 2.7\text{ V}$	0	-	20	ns/V
		$V_{CC} = 2.7\text{ V to } 3.6\text{ V}$	0	-	10	ns/V

10. Static characteristics

Table 7: Static characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$T_{amb} = -40\text{ °C to } +85\text{ °C}$ [1]						
V_{IH}	HIGH-level input voltage	$V_{CC} = 1.2\text{ V}$	V_{CC}	-	-	V
		$V_{CC} = 2.7\text{ V to } 3.6\text{ V}$	2.0	-	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 1.2\text{ V}$	-	-	GND	V
		$V_{CC} = 2.7\text{ V to } 3.6\text{ V}$	-	-	0.8	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH}\text{ or } V_{IL}$				
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 2.7\text{ V to } 3.6\text{ V}$	$V_{CC} - 0.2$	V_{CC}	-	V
		$I_O = -12\text{ mA}; V_{CC} = 2.7\text{ V}$	$V_{CC} - 0.5$	-	-	V
		$I_O = -18\text{ mA}; V_{CC} = 3.0\text{ V}$	$V_{CC} - 0.6$	-	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}\text{ or } V_{IL}$				
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 2.7\text{ V to } 3.6\text{ V}$	-	-	0.2	V
		$I_O = 12\text{ mA}; V_{CC} = 2.7\text{ V}$	-	-	0.4	V
		$I_O = 24\text{ mA}; V_{CC} = 3.0\text{ V}$	-	-	0.55	V
I_{LI}	input leakage current	$V_{CC} = 3.6\text{ V}; V_I = 5.5\text{ V or GND}$	-	± 0.1	± 5	μA
I_{CC}	quiescent supply current	$V_{CC} = 3.6\text{ V}; V_I = V_{CC}\text{ or GND}; I_O = 0\text{ A}$	-	0.1	10	μA
ΔI_{CC}	additional quiescent supply current	$V_{CC} = 2.7\text{ V to } 3.6\text{ V}; V_I = V_{CC} - 0.6\text{ V}; I_O = 0\text{ A}$	-	5	500	μA
C_I	input capacitance		-	5.0	-	pF
$T_{amb} = -40\text{ °C to } +125\text{ °C}$						
V_{IH}	HIGH-level input voltage	$V_{CC} = 1.2\text{ V}$	V_{CC}	-	-	V
		$V_{CC} = 2.7\text{ V to } 3.6\text{ V}$	2.0	-	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 1.2\text{ V}$	-	-	GND	V
		$V_{CC} = 2.7\text{ V to } 3.6\text{ V}$	-	-	0.8	V

Table 7: Static characteristics ...continued

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = -100 μA; V _{CC} = 2.7 V to 3.6 V	V _{CC} - 0.3	V _{CC}	-	V
		I _O = -12 mA; V _{CC} = 2.7 V	V _{CC} - 0.65	-	-	V
		I _O = -18 mA; V _{CC} = 3.0 V	V _{CC} - 0.75	-	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = 100 μA; V _{CC} = 2.7 V to 3.6 V	-	-	0.3	V
		I _O = 12 mA; V _{CC} = 2.7 V	-	-	0.6	V
		I _O = 24 mA; V _{CC} = 3.0 V	-	-	0.8	V
I _{LI}	input leakage current	V _{CC} = 3.6 V; V _I = 5.5 V or GND	-	-	±20	μA
I _{CC}	quiescent supply current	V _{CC} = 3.6 V; V _I = V _{CC} or GND; I _O = 0 A	-	-	40	μA
ΔI _{CC}	additional quiescent supply current	V _{CC} = 2.7 V to 3.6 V; V _I = V _{CC} - 0.6 V; I _O = 0 A	-	-	5	mA

[1] All typical values are measured at V_{CC} = 3.3 V and T_{amb} = 25 °C.

11. Dynamic characteristics

Table 8: Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); for test circuit see [Figure 6](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
T_{amb} = -40 °C to +85 °C [1]							
t _{PHL} , t _{PLH}	propagation delay CP to Qn	see Figure 4					
		V _{CC} = 1.2 V	-	15.0	-	ns	
		V _{CC} = 2.7 V	1.5	4.9	7.9	ns	
		V _{CC} = 3.0 V to 3.6 V	[2] 1.5	4.6	7.6	ns	
t _W	clock pulse width HIGH or LOW	see Figure 4					
		V _{CC} = 1.2 V	-	-	-	ns	
		V _{CC} = 2.7 V	5.0	1.6	-	ns	
		V _{CC} = 3.0 V to 3.6 V	[2] 4	1.0	-	ns	
t _{su}	set-up time E to CP	see Figure 5					
		V _{CC} = 1.2 V	-	-	-	ns	
		V _{CC} = 2.7 V	5.0	0.6	-	ns	
			V _{CC} = 3.0 V to 3.6 V	[2] 3	0.2	-	ns
	Dn to CP	see Figure 5					
		V _{CC} = 1.2 V	-	-	-	ns	
V _{CC} = 2.7 V		3.0	1.0	-	ns		
		V _{CC} = 3.0 V to 3.6 V	[2] 2.0	0.7	-	ns	

Table 8: Dynamic characteristics ...continued
 Voltages are referenced to GND (ground = 0 V); for test circuit see [Figure 6](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
t_h	hold time \bar{E} to CP	see Figure 5					
		$V_{CC} = 1.2\text{ V}$	-	-	-	ns	
		$V_{CC} = 2.7\text{ V}$	0	-1.0	-	ns	
	Dn to CP	$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	[2]	1.0	0	-	ns
		see Figure 5					
		$V_{CC} = 1.2\text{ V}$	-	-	-	ns	
		$V_{CC} = 2.7\text{ V}$	0	-1.1	-	ns	
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	0	-1.0	-	ns	
		f_{max}	maximum clock frequency	see Figure 4			
$V_{CC} = 1.2\text{ V}$	-			-	-	MHz	
$V_{CC} = 2.7\text{ V}$	150			-	-	MHz	
$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	[2]			150	330	-	MHz
$t_{sk(0)}$	skew	$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	[3]	-	-	1.0	ns
C_{PD}	power dissipation capacitance per flip-flop		[4][5]	-	22	-	pF
$T_{amb} = -40\text{ °C to }+125\text{ °C}$							
t_{PHL}, t_{PLH}	propagation delay CP to Qn	see Figure 4					
		$V_{CC} = 1.2\text{ V}$	-	-	-	ns	
		$V_{CC} = 2.7\text{ V}$	1.5	-	10	ns	
t_W	clock pulse width HIGH or LOW	$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	1.5	-	9.5	ns	
		see Figure 4					
		$V_{CC} = 1.2\text{ V}$	-	-	-	ns	
		$V_{CC} = 2.7\text{ V}$	5.0	-	-	ns	
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	4.0	-	-	ns	
		t_{su}	set-up time \bar{E} to CP	see Figure 5			
$V_{CC} = 1.2\text{ V}$	-			-	-	ns	
$V_{CC} = 2.7\text{ V}$	5.0			-	-	ns	
Dn to CP	$V_{CC} = 3.0\text{ V to }3.6\text{ V}$		3.0	-	-	ns	
	see Figure 5						
	$V_{CC} = 1.2\text{ V}$		-	-	-	ns	
	$V_{CC} = 2.7\text{ V}$		3.0	-	-	ns	
	$V_{CC} = 3.0\text{ V to }3.6\text{ V}$		2.0	-	-	ns	

Table 8: Dynamic characteristics ...continued

Voltages are referenced to GND (ground = 0 V); for test circuit see [Figure 6](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit		
t_h	hold time \bar{E} to CP	see Figure 5						
		$V_{CC} = 1.2\text{ V}$	-	-	-	ns		
		$V_{CC} = 2.7\text{ V}$	0	-	-	ns		
	Dn to CP	see Figure 5	$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	1.0	-	-	ns	
			$V_{CC} = 1.2\text{ V}$	-	-	-	ns	
			$V_{CC} = 2.7\text{ V}$	0	-	-	ns	
		Dn to CP	see Figure 5	$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	0	-	-	ns
				$V_{CC} = 1.2\text{ V}$	-	-	-	ns
				$V_{CC} = 2.7\text{ V}$	0	-	-	ns
f_{max}	maximum clock frequency	see Figure 4						
		$V_{CC} = 1.2\text{ V}$	-	-	-	MHz		
		$V_{CC} = 2.7\text{ V}$	150	-	-	MHz		
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	150	-	-	MHz		
$t_{sk(0)}$	skew	$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	[3]	-	-	1.5 ns		

[1] Typical values are measured at $T_{amb} = 25\text{ }^\circ\text{C}$.

[2] Typical value is measured at $V_{CC} = 3.3\text{ V}$.

[3] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.

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

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

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

[5] The condition is $V_I = \text{GND to } V_{CC}$.

12. Waveforms

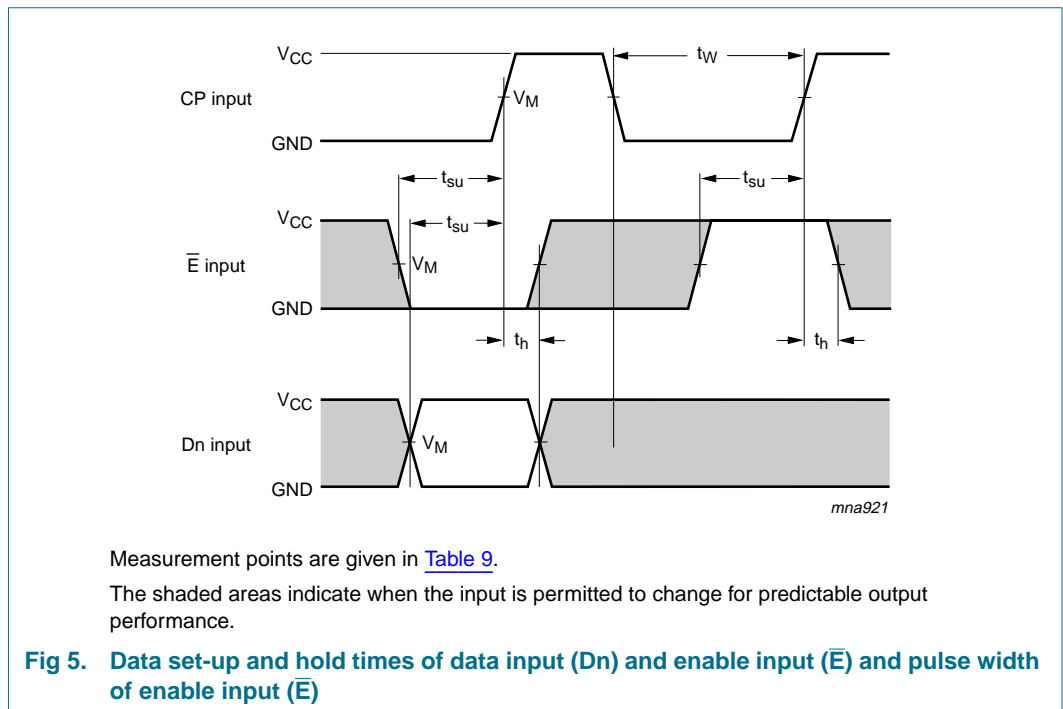
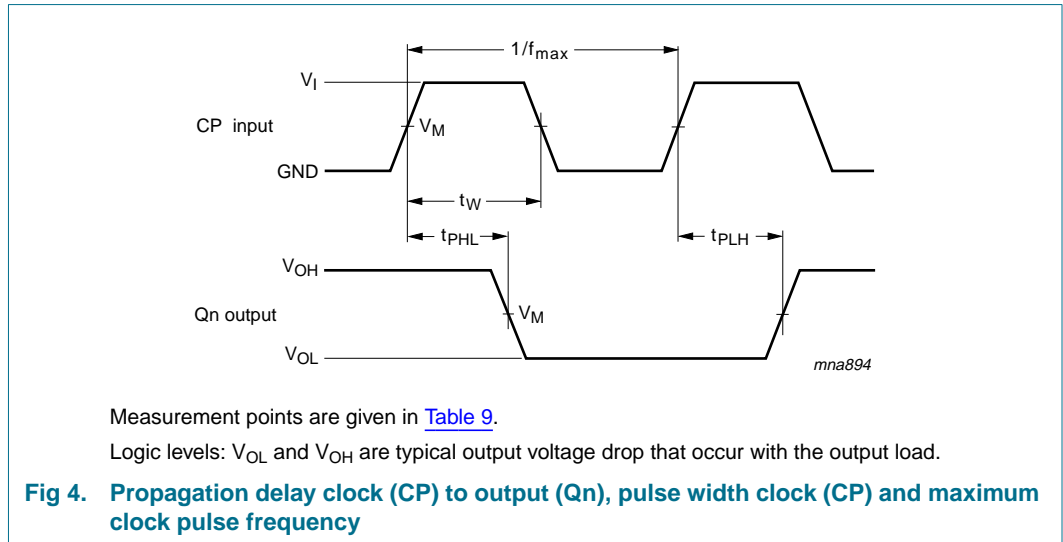


Table 9: Measurement points

Supply voltage	Input	Output
V_{CC}	V_M	V_M
1.2 V	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
2.7 V	1.5 V	1.5 V
3.0 V to 3.6 V	1.5 V	1.5 V

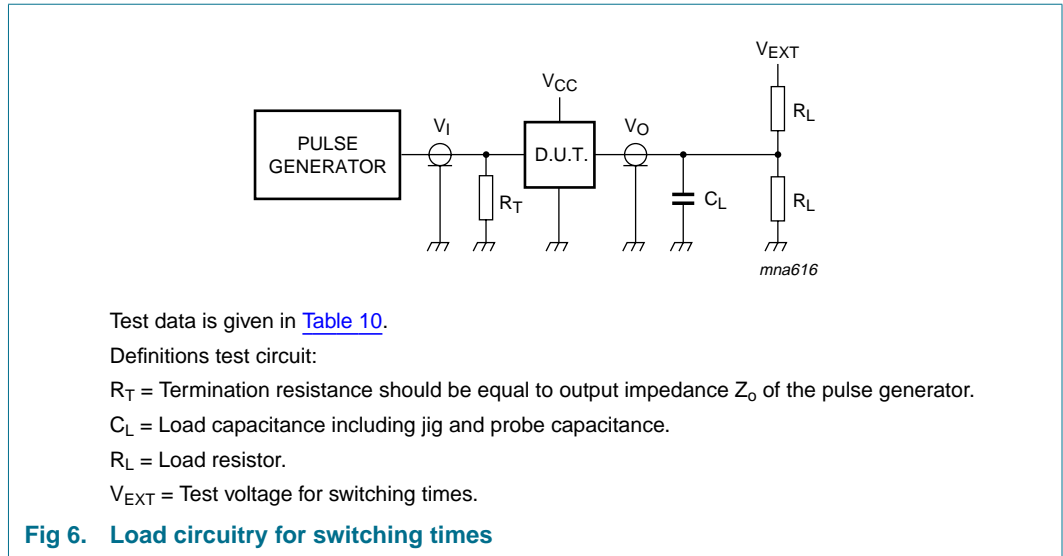


Table 10: Test data

Supply voltage	Input		Load		V_{EXT}
V_{CC}	V_I	t_r, t_f	C_L	R_L	t_{PLH}, t_{PHL}
1.2 V	V_{CC}	≤ 2.5 ns	50 pF	500 Ω [1]	open
2.7 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open
3.0 V to 3.6 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open

[1] The circuit performs better when $R_L = 1000 \Omega$.

13. Package outline

SO20: plastic small outline package; 20 leads; body width 7.5 mm

SOT163-1

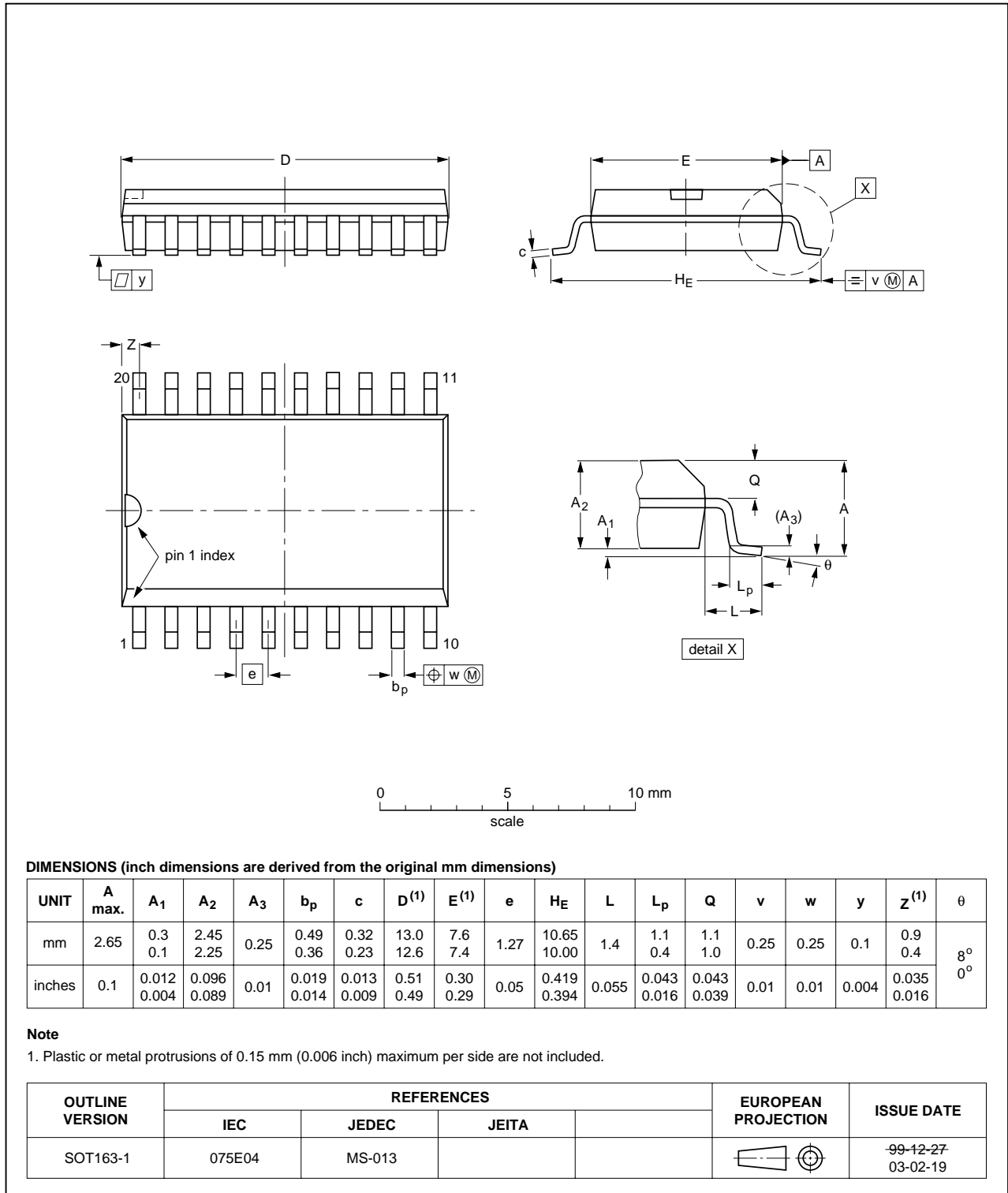


Fig 7. Package outline SOT163-1 (SO20)

SSOP20: plastic shrink small outline package; 20 leads; body width 5.3 mm

SOT339-1

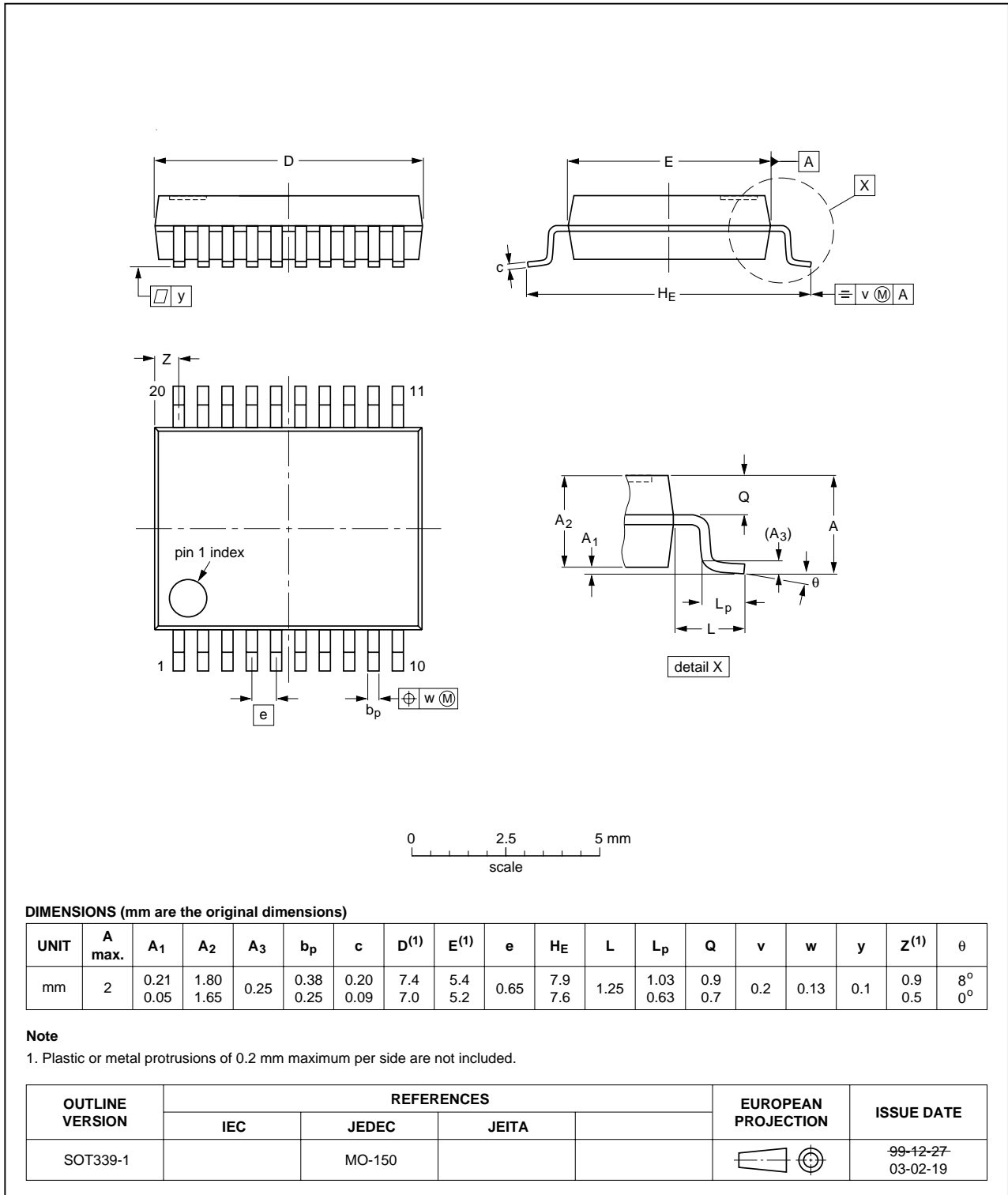


Fig 8. Package outline SOT339-1 (SSOP20)

TSSOP20: plastic thin shrink small outline package; 20 leads; body width 4.4 mm

SOT360-1

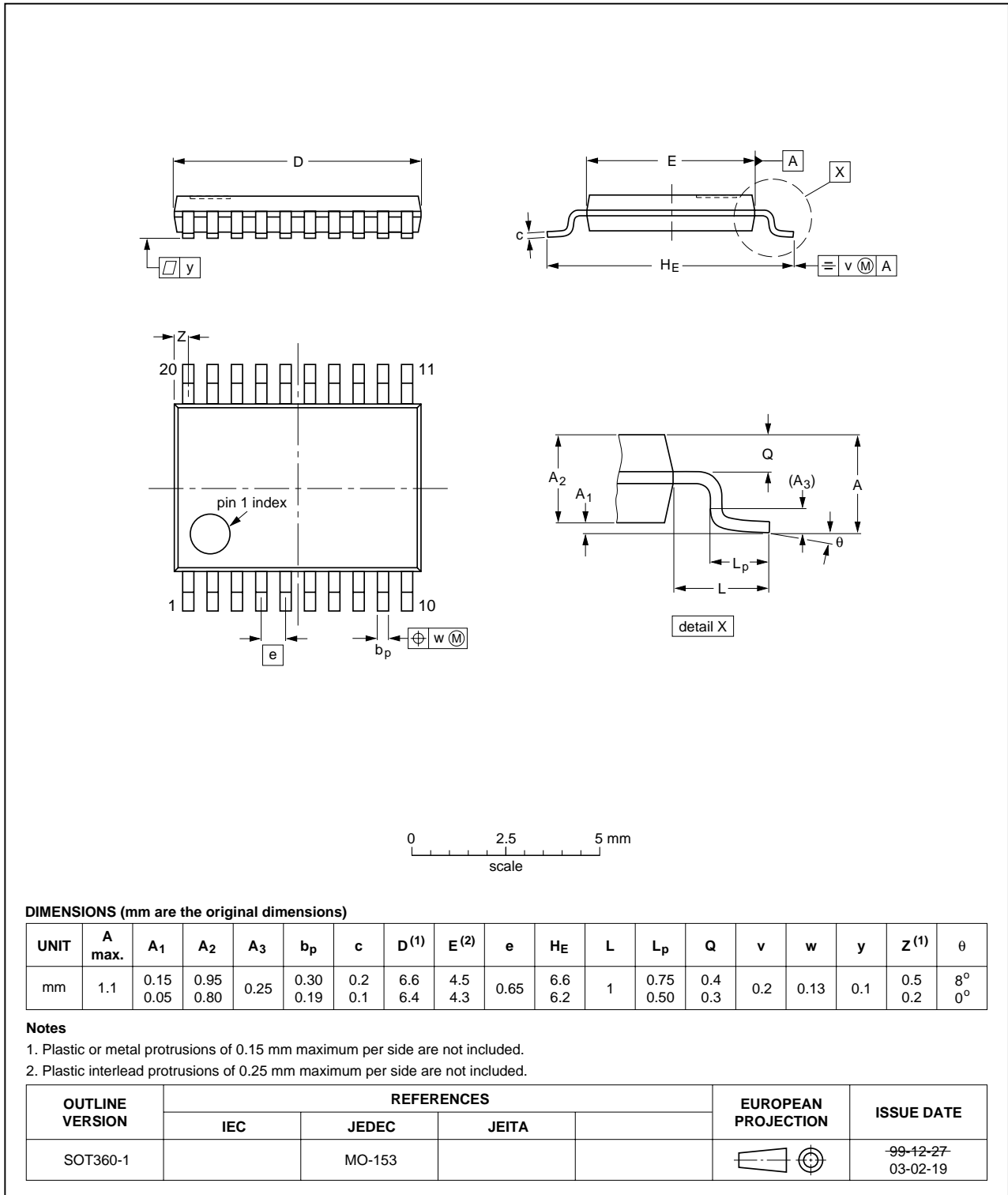


Fig 9. Package outline SOT360-1 (TSSOP20)

14. Revision history

Table 11: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
74LVC377_5	20050221	Product data sheet	-	9397 750 14589	74LVC377_4
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors. Table 8 "Dynamic characteristics": changed maximum values of propagation delay t_{PHL} and t_{PLH} at $T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$ and 2.7 V from 7.9 ns into 10.0 ns and at 3.0 V to 3.6 V from 7.6 ns into 9.5 ns. 				
74LVC377_4	20040528	Product specification	-	9397 750 10615	74LVC377_3
74LVC377_3	20021023	Product specification	-	9397 750 10513	74LVC377_2
74LVC377_2	19980729	Product specification	-	9397 750 04508	74LVC377_1
74LVC377_1	19960606	Product specification	-	-	-

15. Data sheet status

Level	Data sheet status ^[1]	Product status ^[2] ^[3]	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
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[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

16. Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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