

74HC138-Q100; 74HCT138-Q100

3-to-8 line decoder/demultiplexer; inverting

Rev. 3 — 26 March 2018

Product data sheet

1 General description

The 74HC138-Q100; 74HCT138-Q100 decodes three binary weighted address inputs (A0, A1 and A2) to eight mutually exclusive outputs ($\bar{Y}0$ to $\bar{Y}7$). The device features three enable inputs ($\bar{E}1$, $\bar{E}2$ and E3). Every output will be HIGH unless $\bar{E}1$ and $\bar{E}2$ are LOW and E3 is HIGH. This multiple enable function allows easy parallel expansion to a 1-of-32 (5 to 32 lines) decoder with just four '138 ICs and one inverter. The '138 can be used as an eight output demultiplexer by using one of the active LOW enable inputs as the data input and the remaining enable inputs as strobes. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

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 °C to +85 °C and from -40 °C to +125 °C
- Complies with JEDEC standard no. 7A
- Input levels:
 - For 74HC138-Q100: CMOS level
 - For 74HCT138-Q100: TTL level
- Demultiplexing capability
- Multiple input enable for easy expansion
- Ideal for memory chip select decoding
- Active LOW mutually exclusive outputs
- 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 Ω)
- Multiple package options

3 Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC138D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT138D-Q100				
74HC138PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT138PW-Q100				
74HC138BQ-Q100	-40 °C to +125 °C	DHVQFN16	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 × 3.5 × 0.85 mm	SOT763-1
74HCT138BQ-Q100				

4 Functional diagram

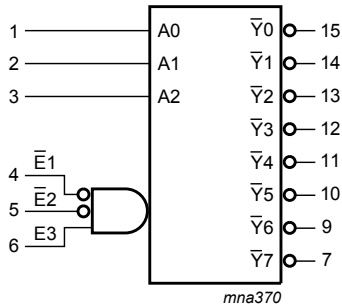


Figure 1. Logic symbol

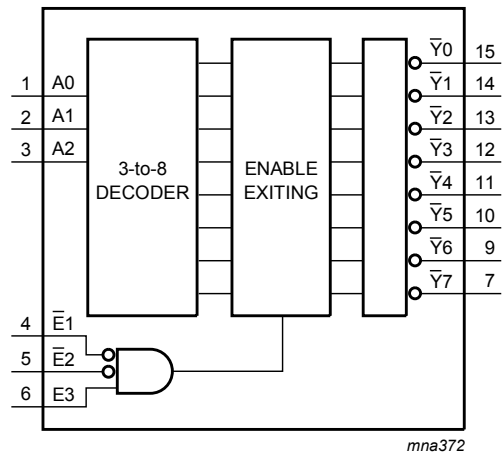


Figure 2. Functional diagram

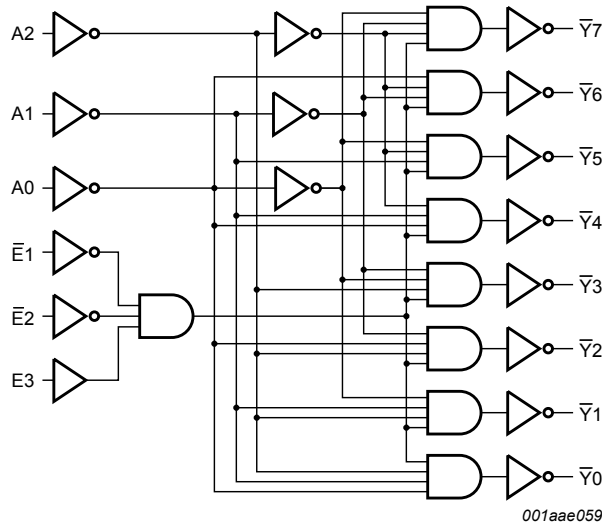
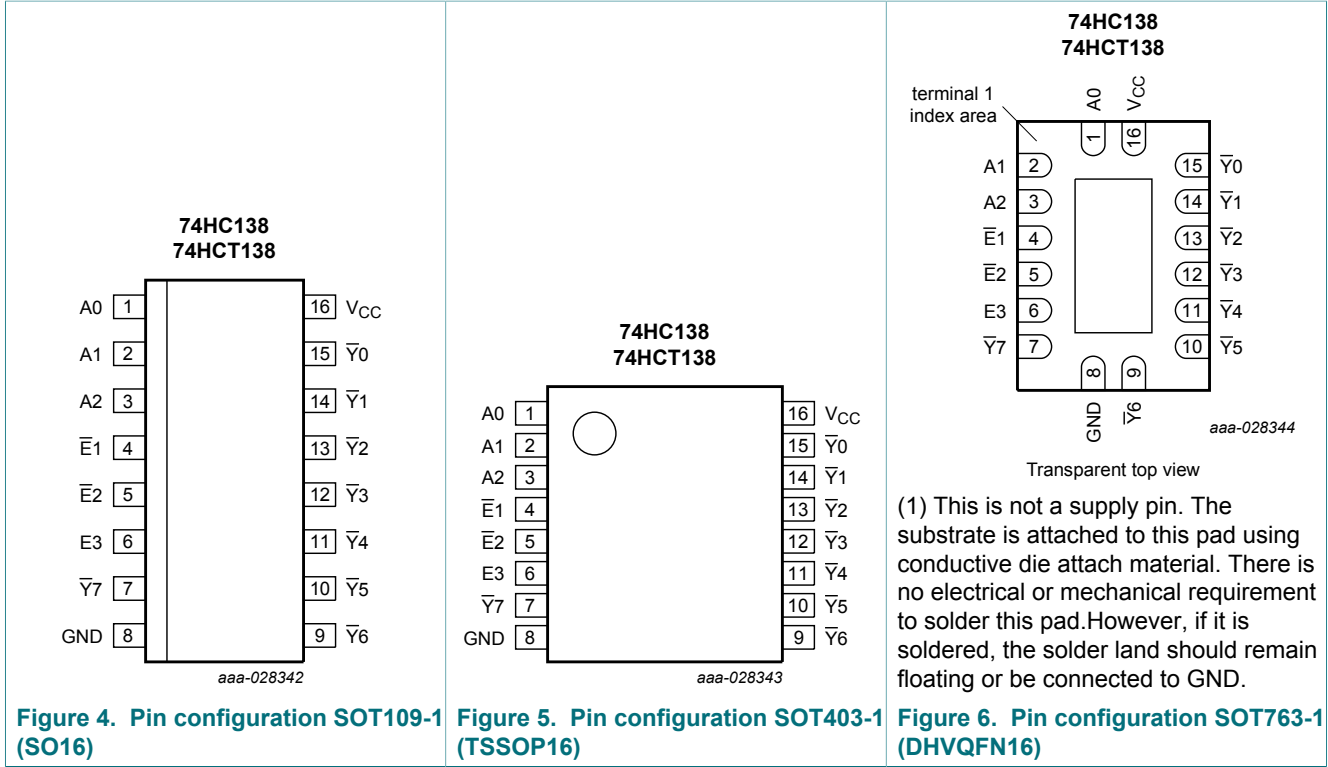


Figure 3. Logic diagram

5 Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
A0, A1, A2	1, 2, 3	address input
$\bar{E}1, \bar{E}2$	4, 5	enable input (active LOW)
E3	6	enable input (active HIGH)
$\bar{Y}0, \bar{Y}1, \bar{Y}2, \bar{Y}3, \bar{Y}4, \bar{Y}5, \bar{Y}6, \bar{Y}7$	15, 14, 13, 12, 11, 10, 9, 7	output (active LOW)
GND	8	ground (0 V)
V _{CC}	16	supply voltage

6 Functional description

Table 3. Function table ^[1]

Control			Input			Output							
$\bar{E}1$	$\bar{E}2$	E3	A2	A1	A0	$\bar{Y}7$	$\bar{Y}6$	$\bar{Y}5$	$\bar{Y}4$	$\bar{Y}3$	$\bar{Y}2$	$\bar{Y}1$	$\bar{Y}0$
H	X	X	X	X	X	H	H	H	H	H	H	H	H
X	H	X											
X	X	L											
L	L	H	L	L	L	H	H	H	H	H	H	H	L
			L	L	H	H	H	H	H	H	H	L	H
			L	H	L	H	H	H	H	H	L	H	H
			L	H	H	H	H	H	H	L	H	H	H
			H	L	L	H	H	H	L	H	H	H	H
			H	L	H	H	H	L	H	H	H	H	H
			H	H	L	H	L	H	H	H	H	H	H
			H	H	H	L	H	H	H	H	H	H	H

[1] H = HIGH voltage level;
L = LOW voltage level;
X = don't care.

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	+7	V
I_{IK}	input clamping current	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	-	± 20	mA
I_{OK}	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	-	± 20	mA
I_O	output current	$V_O = -0.5\text{ V}$ to $(V_{CC} + 0.5\text{ V})$	-	± 25	mA
I_{CC}	quiescent supply current		-	50	mA
I_{GND}	ground current		-50	-	mA
T_{stg}	storage temperature		-65	+150	°C
P_{tot}	total power dissipation		-	500	mW

[1] For SO16 package: P_{tot} derates linearly with 8 mW/K above 70 °C.
For TSSOP16 packages: P_{tot} derates linearly with 5.5 mW/K above 60 °C.
For DHVQFN16 packages: P_{tot} derates linearly with 4.5 mW/K above 60 °C.

8 Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC138-Q100			74HCT138-Q100			Unit
			Min	Typ	Max	Min	Typ	Max	
V _{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V _I	input voltage		0	-	V _{CC}	0	-	V _{CC}	V
V _O	output voltage		0	-	V _{CC}	0	-	V _{CC}	V
T _{amb}	ambient temperature		-40	+25	+125	-40	+25	+125	°C
Δt/ΔV	input transition rise and fall rate	V _{CC} = 2.0 V	-	-	625	-	-	-	ns/V
		V _{CC} = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V _{CC} = 6.0 V	-	-	83	-	-	-	ns/V

9 Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	T _{amb} = 25 °C			T _{amb} = -40 °C to +85 °C		T _{amb} = -40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC138-Q100										
V _{IH}	HIGH-level input voltage	V _{CC} = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V _{CC} = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V _{CC} = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V _{CC} = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V _{CC} = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = -20 μA; V _{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I _O = -20 μA; V _{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -20 μA; V _{CC} = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I _O = -4.0 mA; V _{CC} = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
		I _O = -5.2 mA; V _{CC} = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = 20 μA; V _{CC} = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 μA; V _{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 μA; V _{CC} = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA; V _{CC} = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
		I _O = 5.2 mA; V _{CC} = 6.0 V	-	0.16	0.26	-	0.33	-	0.4	V

Symbol	Parameter	Conditions	T _{amb} = 25 °C			T _{amb} = -40 °C to +85 °C		T _{amb} = -40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 6.0 V	-	-	±0.1	-	±1.0	-	±1.0	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	8.0	-	80	-	160	µA
C _I	input capacitance		-	3.5	-					pF
74HCT138-Q100										
V _{IH}	HIGH-level input voltage	V _{CC} = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = -20 µA	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -4 mA	3.98	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = 20 µA	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA	-	0.15	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	±0.1	-	±1.0	-	±1.0	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	8.0	-	80	-	160	µA
ΔI _{CC}	additional supply current	V _I = V _{CC} - 2.1 V; other inputs at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V; I _O = 0 A								
		per input pin; A _n inputs	-	150	540	-	675	-	735	µA
		per input pin; E _n inputs	-	125	450	-	562.5	-	612.5	µA
		per input pin; E3 input	-	100	360	-	450	-	490	µA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

10 Dynamic characteristics

Table 7. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	$T_{amb} = 25\text{ °C}$			$T_{amb} = -40\text{ °C}$ to $+85\text{ °C}$		$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC138-Q100										
t_{pd}	propagation delay	An to \bar{Y}_n ; see Figure 7 ^[1]								
		$V_{CC} = 2.0$ V	-	41	150	-	190	-	225	ns
		$V_{CC} = 4.5$ V	-	15	30	-	38	-	45	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	12	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	12	26	-	33	-	38	ns
		E3 to \bar{Y}_n ; see Figure 7 ^[1]								
		$V_{CC} = 2.0$ V	-	47	150	-	190	-	225	ns
		$V_{CC} = 4.5$ V	-	17	20	-	38	-	45	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	14	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	14	26	-	33	-	38	ns
		\bar{E}_n to \bar{Y}_n ; see Figure 8 ^[1]								
		$V_{CC} = 2.0$ V	-	47	150	-	190	-	225	ns
		$V_{CC} = 4.5$ V	-	17	20	-	38	-	45	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	14	-	-	-	-	-	ns
$V_{CC} = 6.0$ V	-	14	26	-	33	-	38	ns		
t_t	transition time	\bar{Y}_n ; see Figure 7 and Figure 8 ^[2]								
		$V_{CC} = 2.0$ V	-	19	75	-	95	-	110	ns
		$V_{CC} = 4.5$ V	-	7	15	-	19	-	22	ns
		$V_{CC} = 6.0$ V	-	6	13	-	16	-	19	ns
C_{PD}	power dissipation capacitance	$C_L = 50$ pF; $f = 1$ MHz; $V_I = \text{GND to } V_{CC}$ ^[3]	-	67	-	-	-	-	-	pF

Symbol	Parameter	Conditions	T _{amb} = 25 °C			T _{amb} = -40 °C to +85 °C		T _{amb} = -40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HCT138-Q100										
t _{pd}	propagation delay	An to \bar{Y}_n ; see Figure 7 ^[1]								
		V _{CC} = 4.5 V	-	20	35	-	44	-	53	ns
		V _{CC} = 5 V; C _L = 15 pF	-	17	-	-	-	-	-	ns
		E3 to \bar{Y}_n ; see Figure 7 ^[1]								
		V _{CC} = 4.5 V	-	18	40	-	50	-	60	ns
		V _{CC} = 5 V; C _L = 15 pF	-	19	-	-	-	-	-	ns
		\bar{E}_n to \bar{Y}_n ; see Figure 8 ^[1]								
		V _{CC} = 4.5 V	-	19	40	-	50	-	60	ns
		V _{CC} = 5 V; C _L = 15 pF	-	19	-	-	-	-	ns	
t _t	transition time	\bar{Y}_n ; see Figure 7 and Figure 8 ^[2]								
		V _{CC} = 4.5 V	-	7	15	-	19	-	22	ns
C _{PD}	power dissipation capacitance	C _L = 50 pF; f = 1 MHz; V _I = GND to V _{CC} - 1.5 V ^[3]	-	67	-	-	-	-	-	pF

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

[2] t_t is the same as t_{THL} and t_{TLH}.

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

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

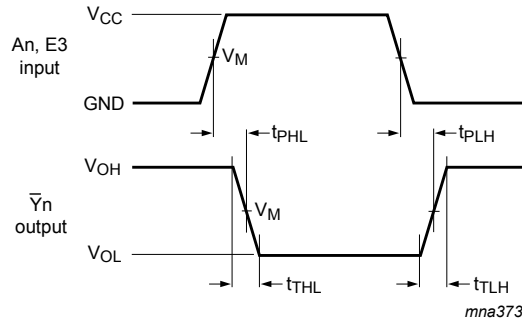
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

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

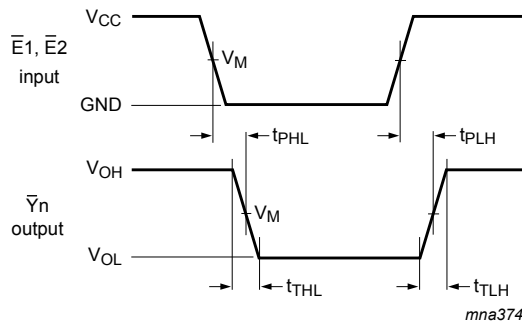
10.1 Waveforms and test circuit



Measurement points are given in [Table 8](#).

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

Figure 7. Propagation delay input (A_n) and enable input (E_3) to output (\bar{Y}_n) and transition time output (\bar{Y}_n)



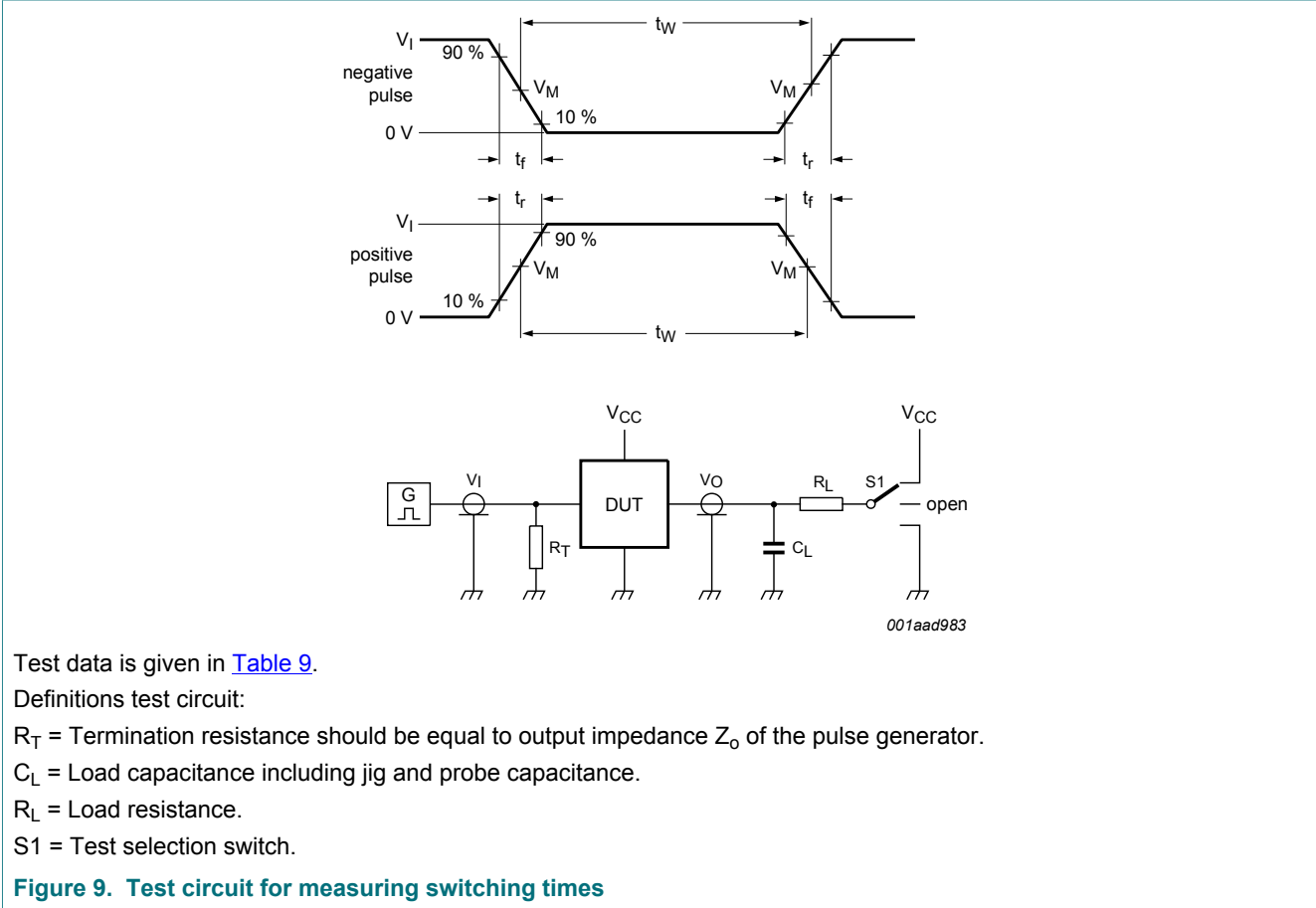
Measurement points are given in [Table 8](#).

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

Figure 8. Propagation delay enable input (\bar{E}_n) to output (\bar{Y}_n) and transition time output (\bar{Y}_n)

Table 8. Measurement points

Type	Input	Output
	V_M	V_M
74HC138-Q100	$0.5V_{CC}$	$0.5V_{CC}$
74HCT138-Q100	1.3 V	1.3 V



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

Definitions test circuit:

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

C_L = Load capacitance including jig and probe capacitance.

R_L = Load resistance.

S1 = Test selection switch.

Figure 9. Test circuit for measuring switching times

Table 9. 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}
74HC138-Q100	V_{CC}	6 ns	15 pF, 50 pF	1 k Ω	open	GND	V_{CC}
74HCT138-Q100	3 V	6 ns	15 pF, 50 pF	1 k Ω	open	GND	V_{CC}

11 Package outline

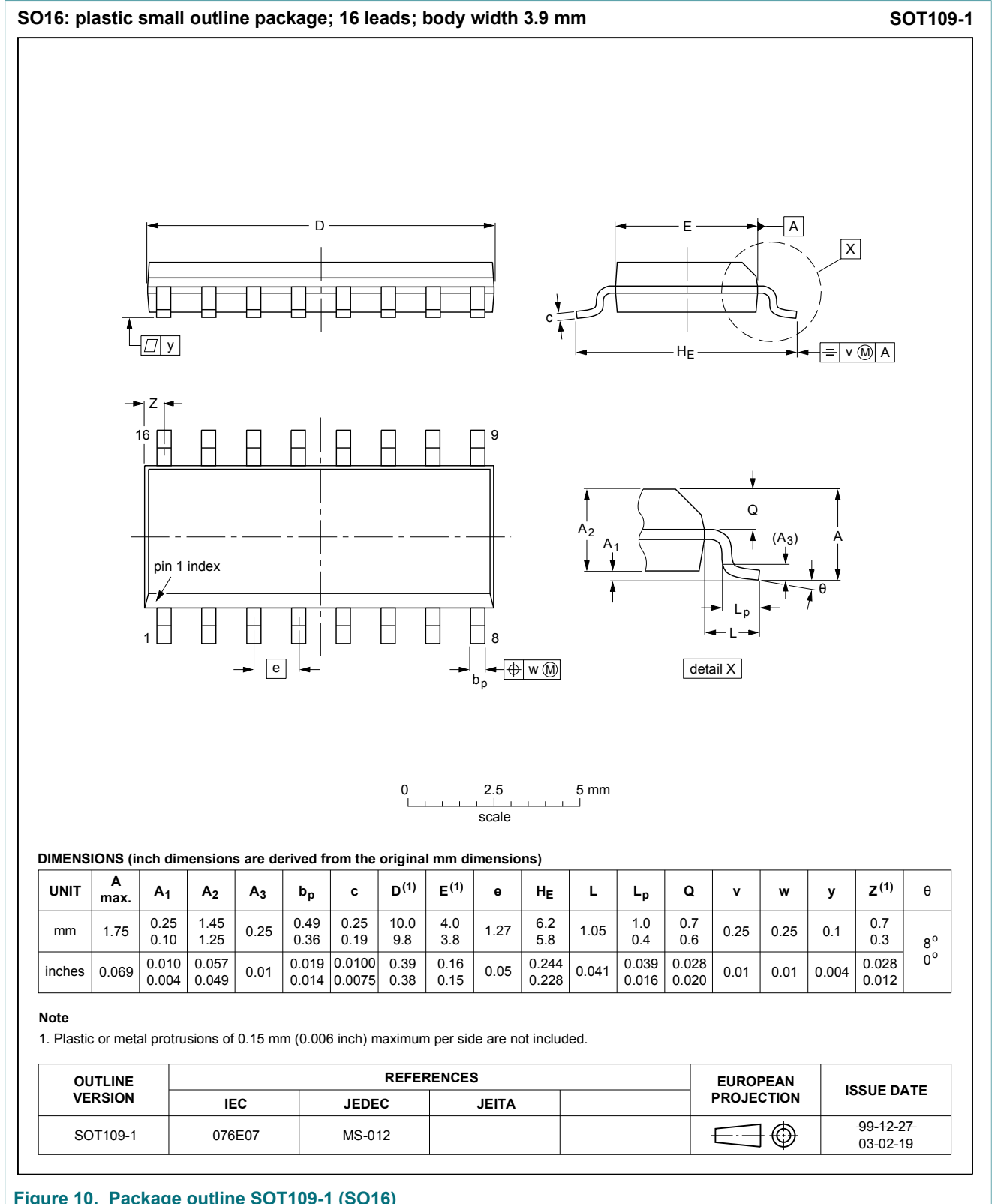
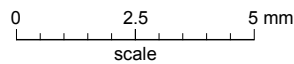
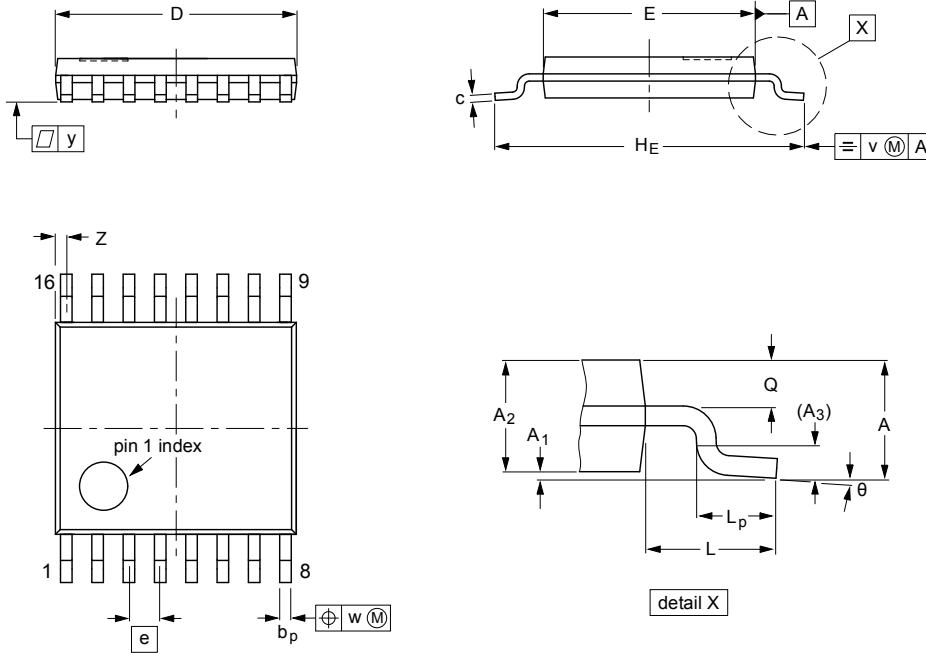


Figure 10. Package outline SOT109-1 (SO16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.40 0.06	8° 0°

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT403-1		MO-153				-99-12-27 03-02-18

Figure 11. Package outline SOT403-1 (TSSOP16)

DHVQFN16: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 x 3.5 x 0.85 mm

SOT763-1

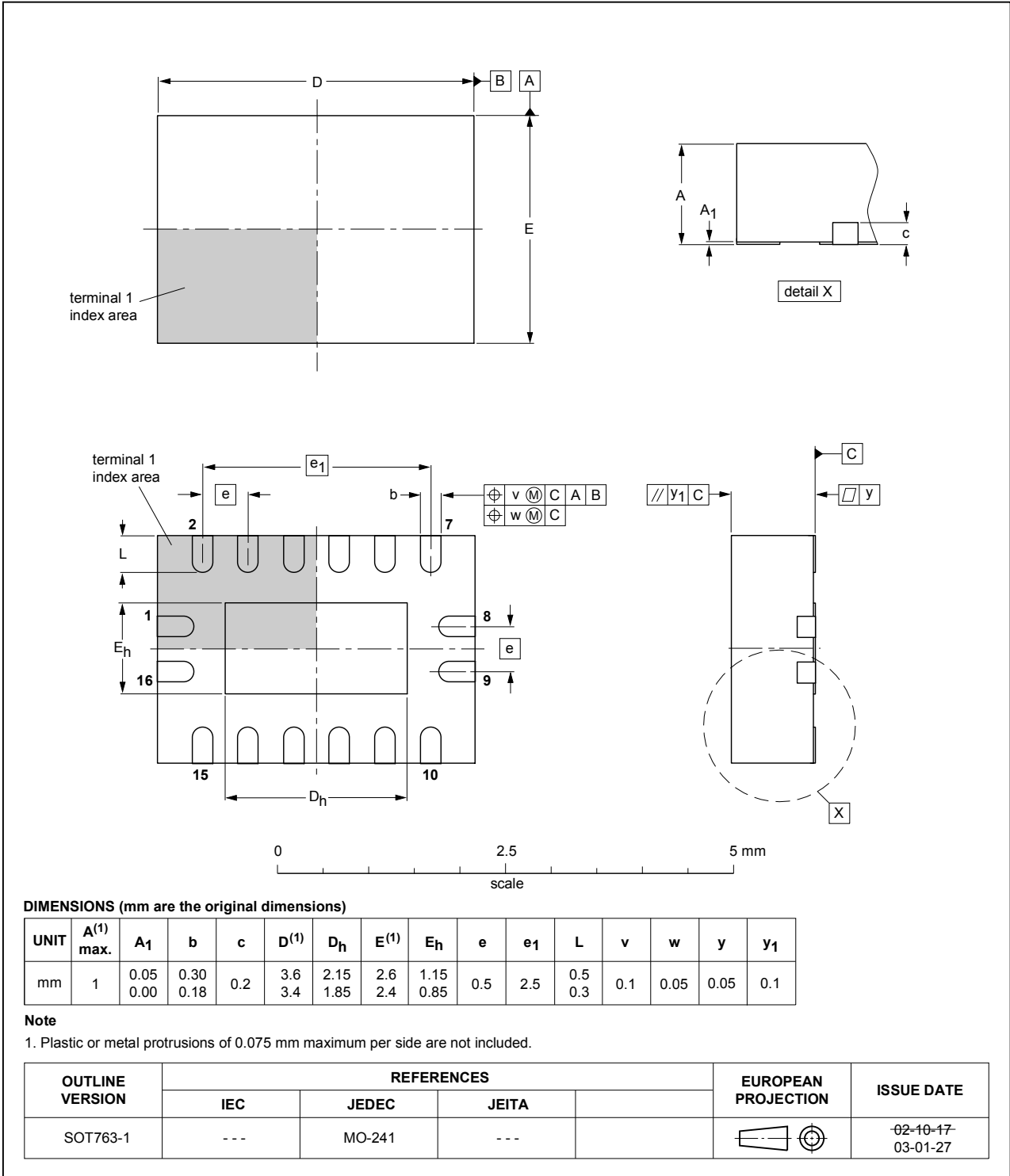


Figure 12. Package outline SOT763-1 (DHVQFN16)

12 Abbreviations

Table 10. Abbreviations

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

13 Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT138_Q100 v.3	20180326	Product data sheet	-	74HC_HCT138_Q100 v.2
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. 			
74HC_HCT138_Q100 v.2	20150126	Product data sheet	-	74HC_HCT138_Q100 v.1
Modifications:	<ul style="list-style-type: none"> Section 9: OFF-state output current removed because device has no 3-state outputs. Section 10: Power dissipation capacitance condition for 74HCT138 is corrected. 			
74HC_HCT138_Q100 v.1	20120716	Product data sheet	-	-

14 Legal information

14.1 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".

[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.nexperia.com>.

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