74HC138-Q100; 74HCT138-Q100

3-to-8 line decoder/demultiplexer; inverting

Rev. 5 — 13 August 2021

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 (\overline{Y} 0 to \overline{Y} 7). The device features three enable inputs (\overline{E} 1, \overline{E} 2 and \overline{E} 3). Every output will be HIGH unless \overline{E} 1 and \overline{E} 2 are LOW and \overline{E} 3 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
- Wide supply voltage range from 2.0 to 6.0 V
- · CMOS low power dissipation
- High noise immunity
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Demultiplexing capability
- Multiple input enable for easy expansion
- · Ideal for memory chip select decoding
- Active LOW mutually exclusive outputs
- Input levels:
 - For 74HC138-Q100: CMOS level
 - For 74HCT138-Q100: TTL level
- Complies with JEDEC standards:
 - JESD8C (2.7 V to 3.6 V)
 - JESD7A (2.0 V to 6.0 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 Ω)
- Multiple package options
- DHVQFN package with Side-Wettable Flanks enabling Automatic Optical Inspection (AOI) of solder joints

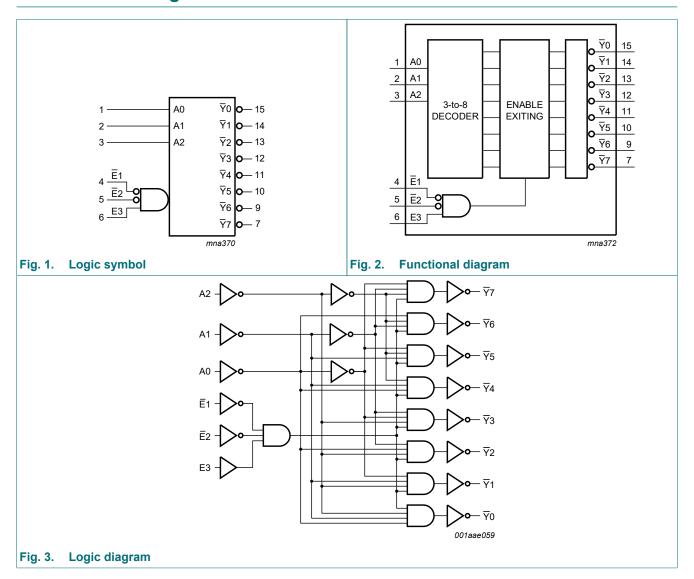


3. Ordering information

Table 1. Ordering information

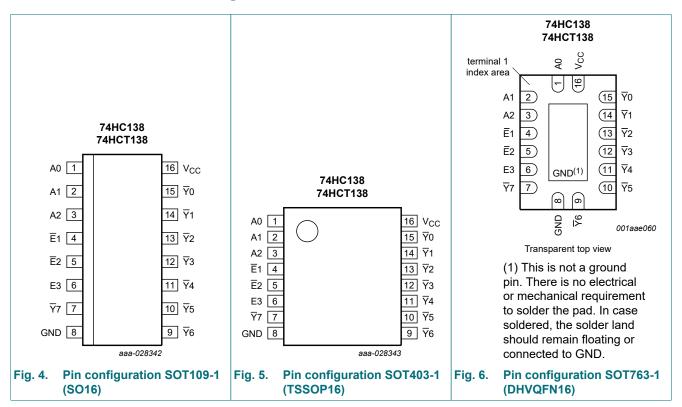
Type number	Package			
	Temperature range	Name	Description	Version
74HC138D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads;	SOT109-1
74HCT138D-Q100	-		body width 3.9 mm	
74HC138PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package;	SOT403-1
74HCT138PW-Q100	-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

4. Functional 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
Ē1, Ē2	4, 5	enable input (active LOW)
E3	6	enable input (active HIGH)
₹0, ₹1, ₹2, ₹3, ₹4, ₹5, ₹6, ₹7	15, 14, 13, 12, 11, 10, 9, 7	output
GND	8	ground (0 V)
V _{CC}	16	supply voltage

6. Functional description

Table 3. Function table

 $H = HIGH \ voltage \ level; \ L = LOW \ voltage \ level; \ X = don't \ care.$

Conti	ol		Input			Outp	Output									
Ē1	Ē2	E3	A2	A1	A0	Y 7	∀ 6	∀ 5	₹ 4	 ₹3	∀ 2	₹ 1	∀ 0			
Н	Х	Х	Х	Х	Х	Н	Н	Н	Н	Н	Н	Н	Н			
X	Н	Х														
X	Х	L														
L	L	Н	L	L	L	Н	Н	Н	Н	Н	Н	Н	L			
			L	L	Н	Н	Н	Н	Н	Н	Н	L	Н			
			L	Н	L	Н	Н	Н	Н	Н	L	Н	Н			
							L	Н	Н	Н	Н	Н	Н	L	Н	Н
			Н	L	L	Н	Н	Н	L	Н	Н	Н	Н			
			Н	L	Н	Н	Н	L	Н	Н	Н	Н	Н			
			Н	Н	L	Н	L	Н	Н	Н	Н	Н	Н			
			Н	Н	Н	L	Н	Н	Н	Н	Н	Н	Н			

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	[1]	-	500	mW

^[1] For SOT109-1 (SO16) package: P_{tot} derates linearly with 12.4 mW/K above 110 °C. For SOT403-1 (TSSOP16) package: P_{tot} derates linearly with 8.5 mW/K above 91 °C. For SOT763-1 (DHVQFN16) package: P_{tot} derates linearly with 11.2 mW/K above 106 °C.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	741	HC138-Q	100	74F	ICT138-C	100	Unit
			Min	Тур	Max	Min	Тур	Max	
V _{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
VI	input voltage		0	-	V _{CC}	0	-	V _{CC}	V
Vo	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	Ta	_{mb} = 25	°C		-40 °C 35 °C	T _{amb} = to +1	Unit	
			Min	Тур	Max	Min	Max	Min	Max	
74HC138	8-Q100									
V _{IH}	HIGH-level	V _{CC} = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
	input voltage	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	V _{CC} = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
	input voltage	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	$V_I = V_{IH}$ or V_{IL}								
	output voltage	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	$V_I = V_{IH}$ or V_{IL}								
	output voltage	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
		$I_O = 20 \mu A; V_{CC} = 6.0 V$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0 \text{ mA}; V_{CC} = 4.5 \text{ V}$	-	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
l _l	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 6.0 \text{ V}$	-	-	±0.1	-	±1.0	-	±1.0	μA
I _{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 6.0 \text{ V}$	-	-	8.0	-	80	-	160	μA
Cı	input capacitance		-	3.5	-					pF

Symbol	Parameter	Conditions	Tai	_{mb} = 25	°C		-40 °C 85 °C	T _{amb} = to +1	Unit	
			Min	Тур	Max	Min	Max	Min	Max	
74HCT1	38-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	$V_I = V_{IH}$ or V_{IL} ; $V_{CC} = 4.5 \text{ V}$								
output voltage		Ι _Ο = -20 μΑ	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -4 mA	3.98	4.32	-	3.84	-	3.7	-	V
0_	LOW-level	$V_I = V_{IH}$ or V_{IL} ; $V_{CC} = 4.5 \text{ V}$								
	output voltage	Ι _Ο = 20 μΑ	-	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; $V_{CC} = 5.5 \text{ V}$	-	-	±0.1	-	±1.0	-	±1.0	μΑ
I _{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5 \text{ V}$	-	-	8.0	-	80	-	160	μA
ΔI _{CC}	additional supply current	$V_1 = V_{CC} - 2.1 \text{ V};$ other inputs at V_{CC} or GND; $V_{CC} = 4.5 \text{ V}$ to 5.5 V ; $I_O = 0 \text{ A}$								
		per input pin; An inputs	-	150	540	-	675	-	735	μΑ
		per input pin; En inputs	-	125	450	-	562.5	-	612.5	μΑ
		per input pin; E3 input	-	100	360	-	450	-	490	μΑ
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 Fig. 9.

Symbol	Parameter	Conditions		Ta	_{imb} = 25	°C		-40 °C 35 °C	T _{amb} = to +1	Unit	
				Min	Тур	Max	Min	Max	Min	Max	
74HC13	8-Q100				•		•	•			
t _{pd}	propagation	An to ₹n; see Fig. 7	[1]								
	delay	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 \overline{Y} n; see $\underline{\text{Fig. 7}}$	[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
		En to Yn; see Fig. 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	₹n; see Fig. 7 and Fig. 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 = GND to V_{CC}	[3]	-	67	-	-	-	-	-	pF

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Symbol	Parameter	Conditions	Та	_{mb} = 25	°C		: -40 °C 85 °C	T _{amb} = to +1	Unit		
				Min	Тур	Max	Min	Max	Min	Max	
74HCT1	38-Q100				•						
t _{pd}	propagation	An to ₹n; see Fig. 7	[1]								
	delay	V _{CC} = 4.5 V		-	20	35	-	44	-	53	ns
		V _{CC} = 5 V; C _L = 15 pF		-	17	-	-	-	-	-	ns
		E3 to \overline{Y} n; see $\underline{\text{Fig. 7}}$	[1]								
		V _{CC} = 4.5 V		-	18	40	-	50	-	60	ns
		V _{CC} = 5 V; C _L = 15 pF		-	19	-	-	-	-	-	ns
		En to ₹n; see Fig. 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	₹n; see Fig. 7 and Fig. 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

- t_{pd} is the same as t_{PLH} and t_{PHL} .
- t_t is the same as t_{THL} and t_{TLH} . C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

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

 f_i = input frequency in MHz;

f_o = output frequency in MHz;

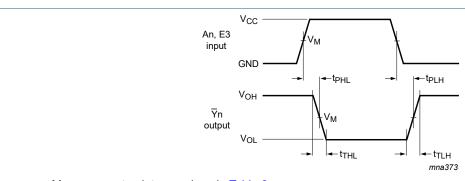
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

 $\Sigma(C_L \times V_{CC}^2 \times f_0) = \text{sum of outputs.}$

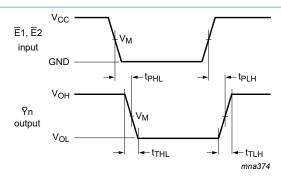
10.1. Waveforms and test circuit



Measurement points are given in Table 8.

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

Propagation delay input (An) and enable input (E3) to output $(\overline{Y}n)$ and transition time output $(\overline{Y}n)$



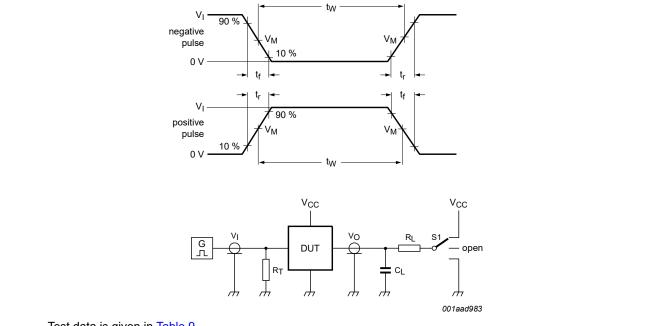
Measurement points are given in Table 8.

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

Propagation delay enable input (En) to output (Yn) and transition time output (Yn)Fig. 8.

Table 8. Measurement points

The state of the s		
Туре	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_0 of the pulse generator.

C_L = Load capacitance including jig and probe capacitance.

R_L = Load resistance.

S1 = Test selection switch.

Fig. 9. Test circuit for measuring switching times

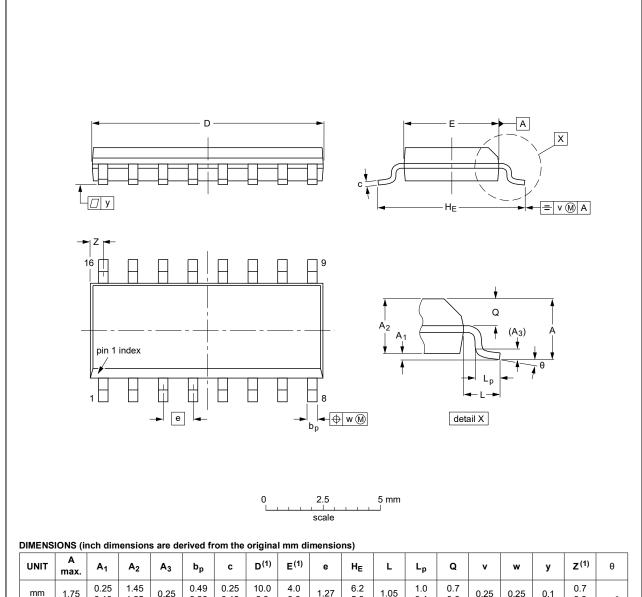
Table 9. Test data

Туре	Input		Load		S1 position				
	V _I	t _r , t _f	CL	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 kΩ	open	GND	V _{CC}		
74HCT138-Q100	3 V	6 ns	15 pF, 50 pF	1 kΩ	open	GND	V _{CC}		

11. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1



UN	IT ma		A ₁	A ₂	A ₃	bp	С	D ⁽¹⁾	E ⁽¹⁾	е	HE	L	Lp	Q	v	w	у	Z ⁽¹⁾	θ
mr	n 1.1	75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8°
inch	es 0.0	069	0.010 0.004	0.057 0.049	0.01		0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	0°

Note

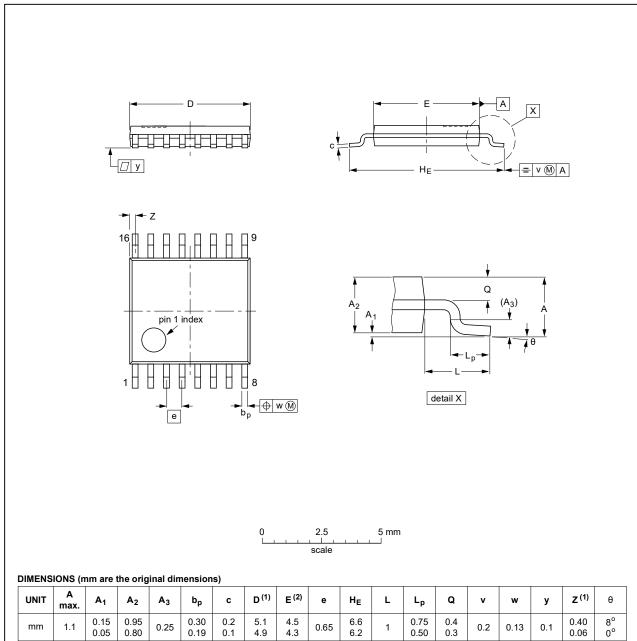
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE	REFERENCES			EUROPEAN	ISSUE DATE	
VERSION	IEC	JEDEC	JEITA		PROJECTION	ISSUE DATE
SOT109-1	076E07	MS-012				99-12-27 03-02-19

Fig. 10. Package outline SOT109-1 (SO16)

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

SOT403-1



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

Fig. 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

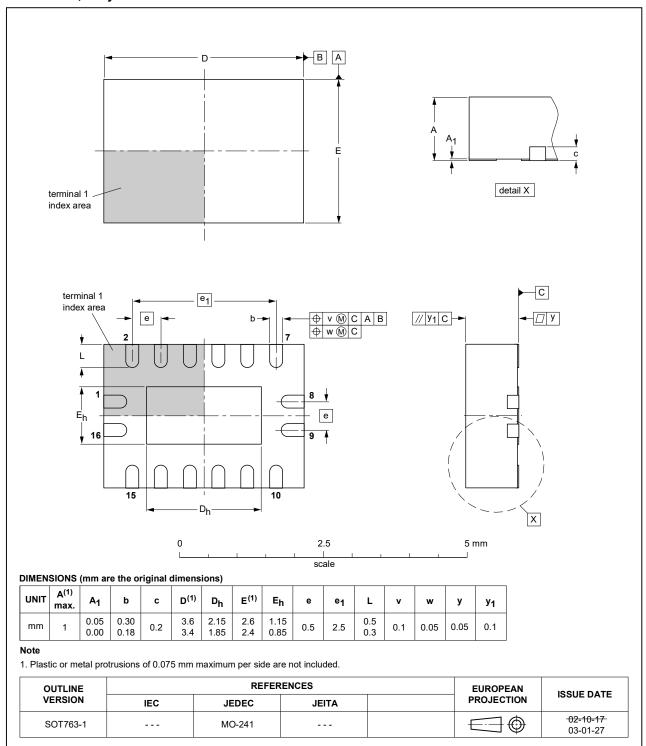


Fig. 12. Package outline SOT763-1 (DHVQFN16)

12. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
НВМ	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.4	20210813	Product data sheet	-	74HC_HCT138_Q100 v.3	
Modifications:	<u>Section 2</u> updated.				
74HC_HCT138_Q100 v.4	20200407	Product data sheet	-	74HC_HCT138_Q100 v.3	
Modifications:	 Section 2 updated. Fig. 6 corrected (Errata). Table 4: Derating values for P_{tot} total power dissipation updated. 				
74HC_HCT138_Q100 v.3	20180326	Product data sheet	-	74HC_HCT138_Q100 v.2	
Modifications:	 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:	 <u>Section 9</u>: OFF-state output current removed because device has no 3-state outputs. <u>Section 10</u>: Power dissipation capacitance condition for 74HCT138 is corrected. 				
74HC_HCT138_Q100 v.1	20120716	Product data sheet	-	-	

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14. Legal information

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.

- Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- 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 https://www.nexperia.com.

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