

74HC238; 74HCT238

3-to-8 line decoder/demultiplexer

Rev. 4 — 27 January 2016

Product data sheet

1. General description

The 74HC238; 74HCT238 decodes three binary weighted address inputs (A0, A1 and A2) to eight mutually exclusive outputs (Y0 to Y7). The device features three enable inputs ($\bar{E}1$ and $\bar{E}2$ and E3). Every output will be LOW 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 '238 ICs and one inverter. The '238 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} .

2. Features and benefits

- Demultiplexing capability
- Multiple input enable for easy expansion
- Ideal for memory chip select decoding
- Active HIGH mutually exclusive outputs
- Multiple package options
- Complies with JEDEC standard no. 7A
- Input levels:
 - ◆ For 74HC238: CMOS level
 - ◆ For 74HCT238: TTL level
- ESD protection:
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$

3. Ordering information

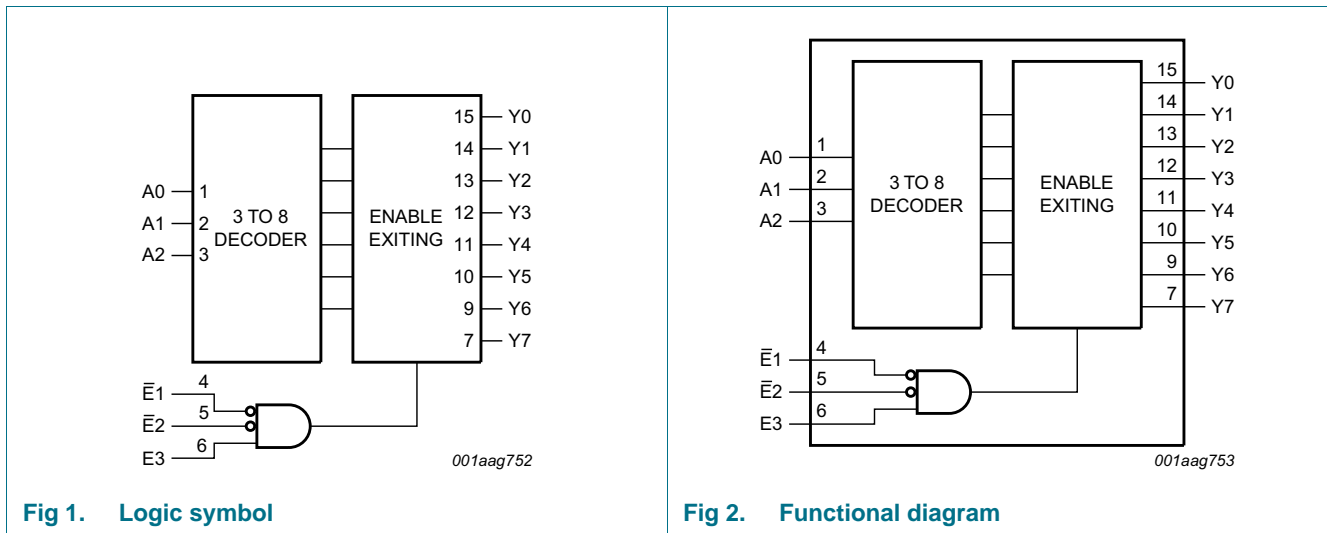
Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC238D	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT238D				
74HC238DB	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HCT238DB				

Table 1. Ordering information ...continued

Type number	Package			Version
	Temperature range	Name	Description	
74HC238PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT238PW				
74HC238BQ	-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
74HCT238BQ				

4. Functional diagram



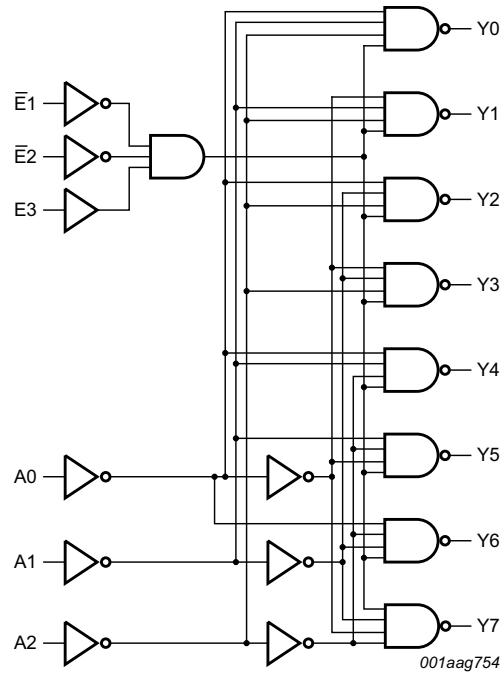
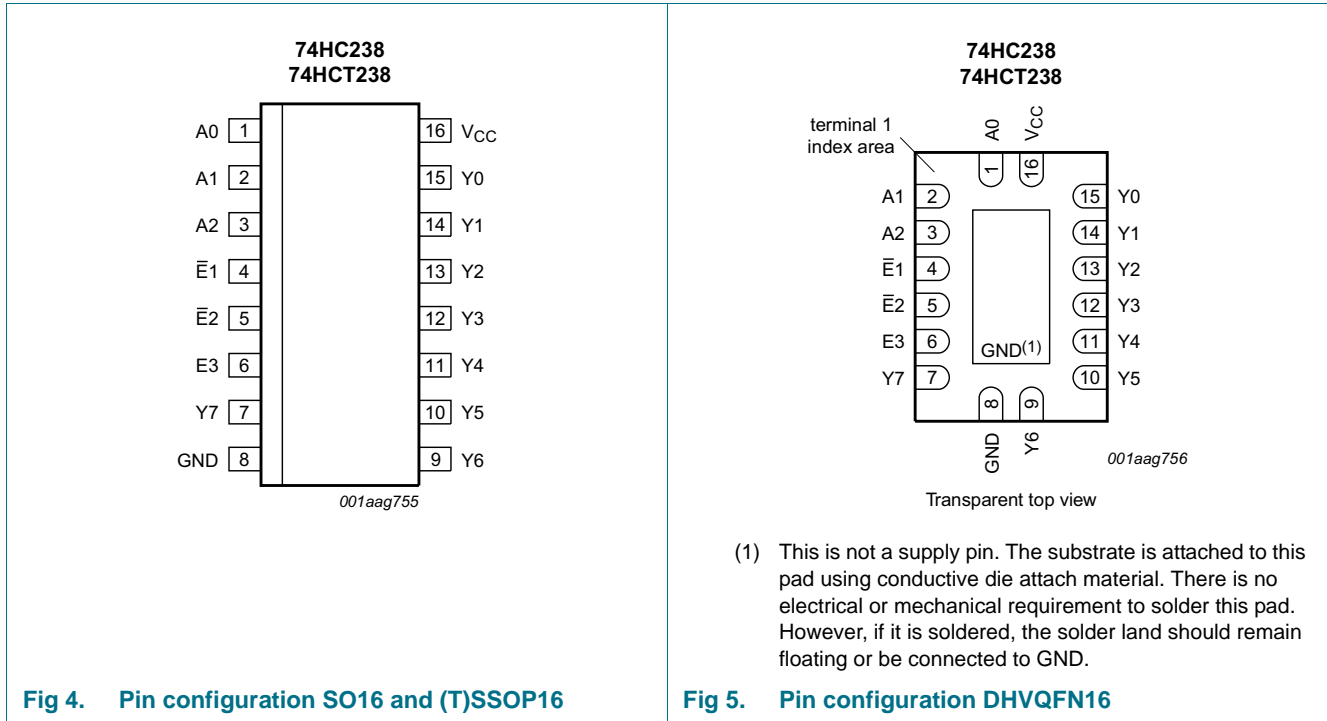


Fig 3. Logic diagram

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
$\bar{E}1$	4	enable input (active LOW)
$\bar{E}2$	5	enable input (active LOW)
E3	6	enable input (active HIGH)
Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7	15, 14, 13, 12, 11, 10, 9, 7	output (active HIGH)
GND	8	ground (0 V)
V _{CC}	16	supply voltage

6. Functional description

Table 3. Function table^[1]

Inputs						Outputs							
E1	E2	E3	A0	A1	A2	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
H	X	X	X	X	X	L	L	L	L	L	L	L	L
X	H	X	X	X	X	L	L	L	L	L	L	L	L
X	X	L	X	X	X	L	L	L	L	L	L	L	L
L	L	H	L	L	L	H	L	L	L	L	L	L	L
L	L	H	H	L	L	L	H	L	L	L	L	L	L
L	L	H	L	H	L	L	L	H	L	L	L	L	L
L	L	H	H	H	L	L	L	L	H	L	L	L	L
L	L	H	L	L	H	L	L	L	L	H	L	L	L
L	L	H	H	L	H	L	L	L	L	L	H	L	L
L	L	H	L	H	H	L	L	L	L	L	L	H	L
L	L	H	H	H	H	L	L	L	L	L	L	L	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 $V_I > V_{CC} + 0.5\text{ V}$ ^[1]	-	±20	mA
I_{OK}	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ ^[1]	-	±20	mA
I_O	output current	$-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$	-	±25	mA
I_{CC}	supply current		-	50	mA
I_{GND}	ground current		-50	-	mA
T_{stg}	storage temperature		-65	+150	°C
P_{tot}	total power dissipation	SO16, (T)SSOP16 and DHVQFN16 packages ^[2]	-	500	mW

- [1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
[2] For SO16 package: above 70 °C the value of P_{tot} derates linearly at 8 mW/K.
For SSOP16 and TSSOP16 packages: above 60 °C the value of P_{tot} derates linearly at 5.5 mW/K.
For DHVQFN16 package: above 60 °C the value of P_{tot} derates linearly at 4.5 mW/K.

8. Recommended operating conditions

Table 5. Recommended operating conditions

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

Symbol	Parameter	Conditions	74HC238			74HCT238			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	-	+125	-40	-	+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	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC238										
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
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 _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 6.0 V	-	-	±0.1	-	±1.0	-	±1.0	μA
		V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	8.0	-	80	-	160	μA

Table 6. Static characteristics ...continued

At recommended operating conditions; 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	
C_I	input capacitance		-	3.5	-	-	-	-	-	pF
74HCT238										
V_{IH}	HIGH-level input voltage	$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	2.0	1.6	-	2.0	-	2.0	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	-	1.2	0.8	-	0.8	-	0.8	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH} \text{ or } V_{IL}; V_{CC} = 4.5 \text{ V}$								
		$I_O = -20 \mu\text{A}$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -4.0 \text{ mA}$	3.98	4.32	-	3.84	-	3.7	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH} \text{ or } V_{IL}; V_{CC} = 4.5 \text{ V}$								
		$I_O = 20 \mu\text{A}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0 \text{ mA}$	-	0.16	0.26	-	0.33	-	0.4	V
I_I	input leakage current	$V_I = V_{CC} \text{ or } \text{GND}; V_{CC} = 5.5 \text{ V}$	-	-	± 0.1	-	± 1.0	-	± 1.0	μA
I_{CC}	supply current	$V_I = V_{CC} \text{ or } \text{GND}; V_{CC} = 5.5 \text{ V}; I_O = 0 \text{ A}$	-	-	8.0	-	80	-	160	μA
ΔI_{CC}	additional supply current	per input pin; $V_I = V_{CC} - 2.1 \text{ V};$ other inputs at V_{CC} or GND; $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V};$ $I_O = 0 \text{ A}$								
		A _n inputs	-	70	252	-	315	-	343	μA
		$\bar{E}1, \bar{E}2$ inputs	-	40	144	-	180	-	196	μA
		E3 input	-	145	522	-	653	-	711	μA
C_I	input capacitance		-	3.5	-	-	-	-	-	pF

10. Dynamic characteristics

Table 7. Dynamic characteristics

$GND = 0\text{ V}$; test circuit see [Figure 8](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +125 °C		Unit
			Min	Typ	Max	Max (85 °C)	Max (125 °C)	
74HC238								
t_{pd}	propagation delay	An to Yn; see Figure 6 [1]						
		$V_{CC} = 2.0\text{ V}$	-	47	150	190	225	ns
		$V_{CC} = 4.5\text{ V}$	-	17	30	38	45	ns
		$V_{CC} = 5.0\text{ V}$; $C_L = 15\text{ pF}$	-	14	-	-	-	ns
		$V_{CC} = 6.0\text{ V}$	-	14	26	33	38	ns
		E3 to Yn; see Figure 6 [1]						
		$V_{CC} = 2.0\text{ V}$	-	52	160	200	240	ns
		$V_{CC} = 4.5\text{ V}$	-	19	32	40	48	ns
		$V_{CC} = 5.0\text{ V}$; $C_L = 15\text{ pF}$	-	16	-	-	-	ns
		$V_{CC} = 6.0\text{ V}$	-	15	27	34	41	ns
		$\bar{E}n$ to Yn or see Figure 7 [1]						
		$V_{CC} = 2.0\text{ V}$	-	50	155	195	235	ns
		$V_{CC} = 4.5\text{ V}$	-	18	31	39	47	ns
		$V_{CC} = 5.0\text{ V}$; $C_L = 15\text{ pF}$	-	17	-	-	-	ns
$V_{CC} = 6.0\text{ V}$	-	14	26	33	40	ns		
t_t	transition time	see Figure 6 and Figure 7 [2]						
		$V_{CC} = 2.0\text{ V}$	-	19	75	95	110	ns
		$V_{CC} = 4.5\text{ V}$	-	7	15	19	22	ns
		$V_{CC} = 6.0\text{ V}$	-	6	13	16	19	ns
C_{PD}	power dissipation capacitance	per package; $V_I = GND$ to V_{CC} [3]	-	72	-	-	-	pF

Table 7. Dynamic characteristics

$GND = 0\text{ V}$; test circuit see [Figure 8](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +125 °C		Unit
			Min	Typ	Max	Max (85 °C)	Max (125 °C)	
74HCT238								
t_{pd}	propagation delay	An to Yn; see Figure 6 ^[1]						
		$V_{CC} = 4.5\text{ V}$	-	19	35	44	53	ns
		$V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$	-	18	-	-	-	ns
		E3 to Yn; see Figure 6 ^[1]						
		$V_{CC} = 4.5\text{ V}$	-	20	37	46	56	ns
		$V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$	-	20	-	-	-	ns
		$\bar{E}n$ to Yn or see Figure 7 ^[1]						
		$V_{CC} = 4.5\text{ V}$	-	20	35	44	53	ns
		$V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$	-	21	-	-	-	ns
t_t	transition time	$V_{CC} = 4.5\text{ V}$; see Figure 6 and Figure 7 ^[2]	-	7	15	19	22	ns
C_{PD}	power dissipation capacitance	per package; $V_I = GND$ to $V_{CC} - 1.5\text{ V}$ ^[3]	-	76	-	-	-	pF

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

[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;

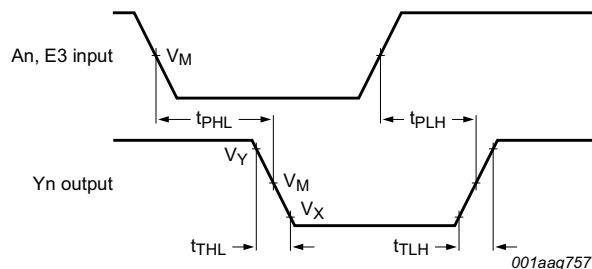
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

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

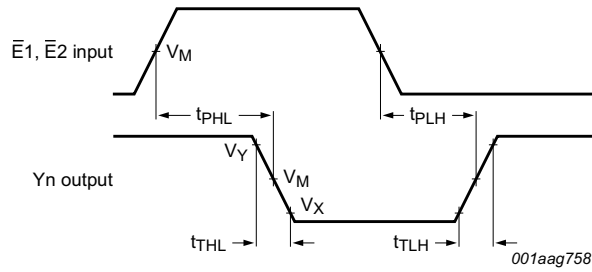
11. Waveforms



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

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

Fig 6. Input (An, E3) to output (Yn) propagation delays and output transition times



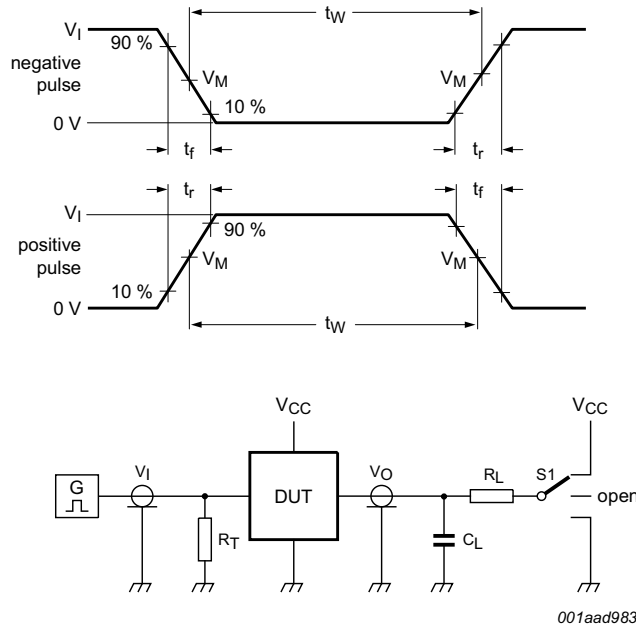
Measurement points are given in [Table 8](#).

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

Fig 7. Input ($\bar{E}1, \bar{E}2$) to output (Y_n) propagation delays and output transition times

Table 8. Measurement points

Type	Input	Output		
	V_M	V_M	V_X	V_Y
74HC238	$0.5V_{CC}$	$0.5V_{CC}$	$0.1V_{CC}$	$0.9V_{CC}$
74HCT238	1.3 V	1.3 V	$0.1V_{CC}$	$0.9V_{CC}$



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

Definitions for 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

Fig 8. 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}
74HC238	V_{CC}	6 ns	15 pF, 50 pF	1 k Ω	open
74HCT238	3 V	6 ns	15 pF, 50 pF	1 k Ω	open

12. Package outline

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

SOT109-1

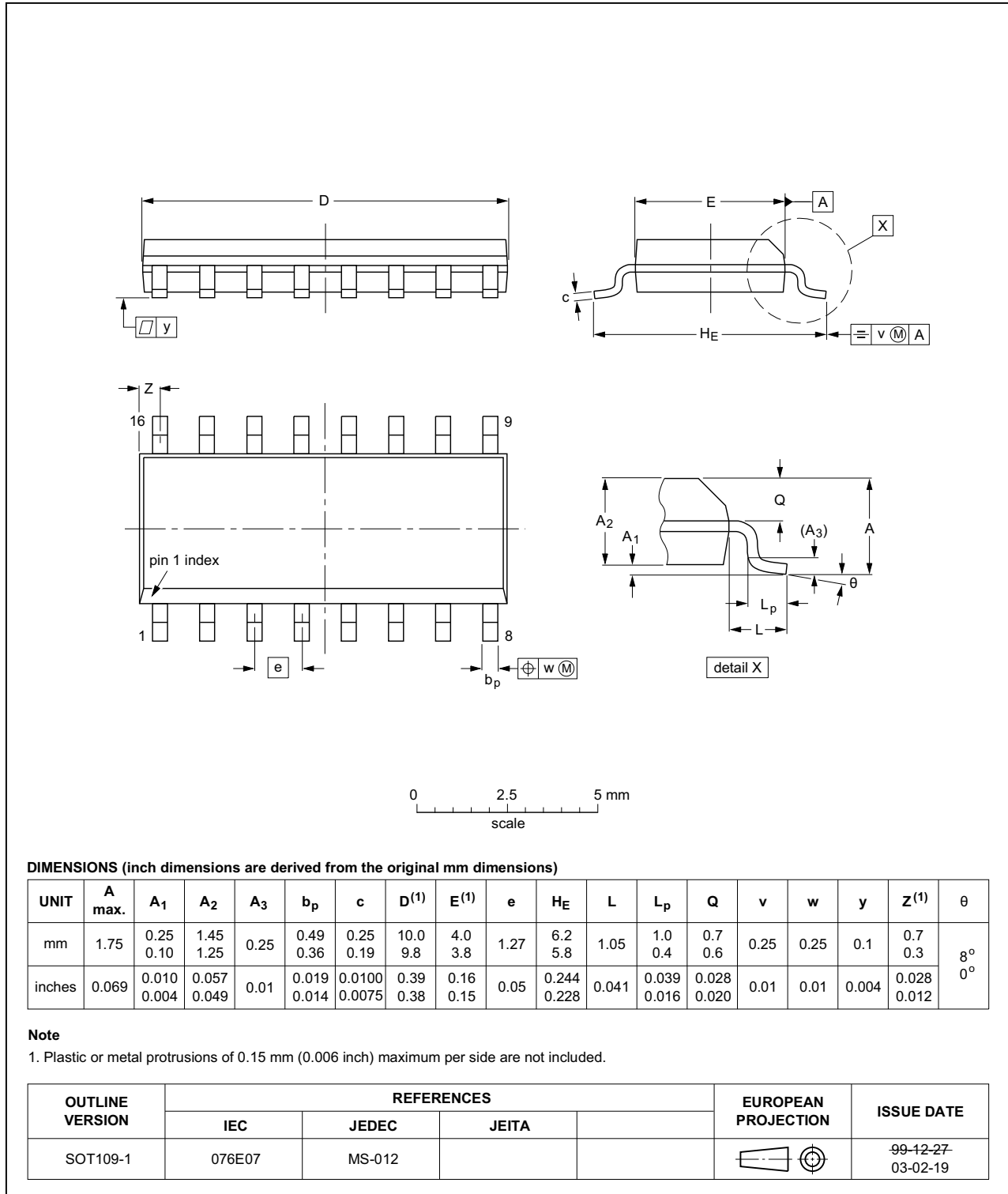


Fig 9. Package outline SOT109-1 (SO16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

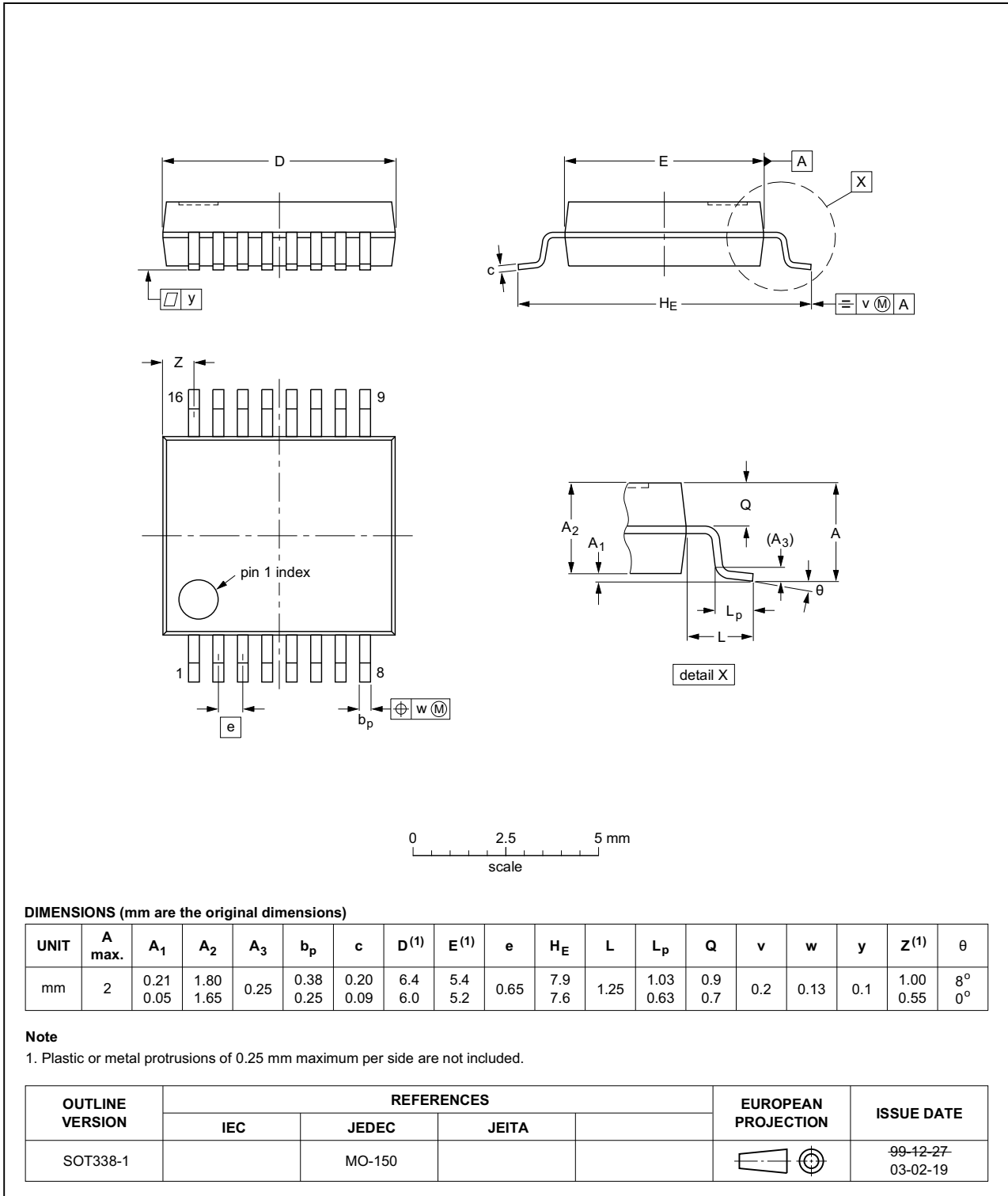


Fig 10. Package outline SOT338-1 (SSOP16)

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

SOT403-1

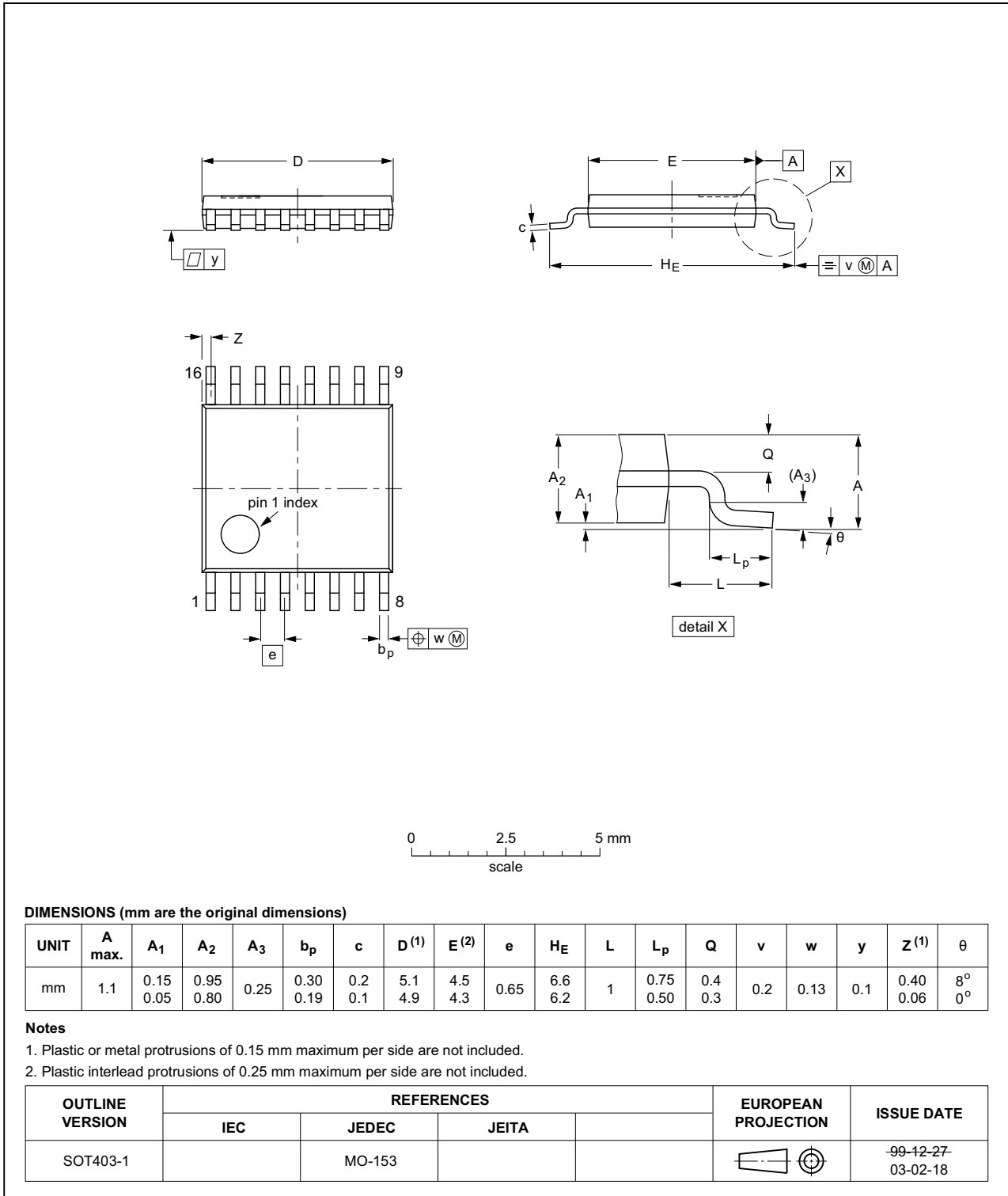


Fig 11. Package outline SOT403-1 (TSSOP16)

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

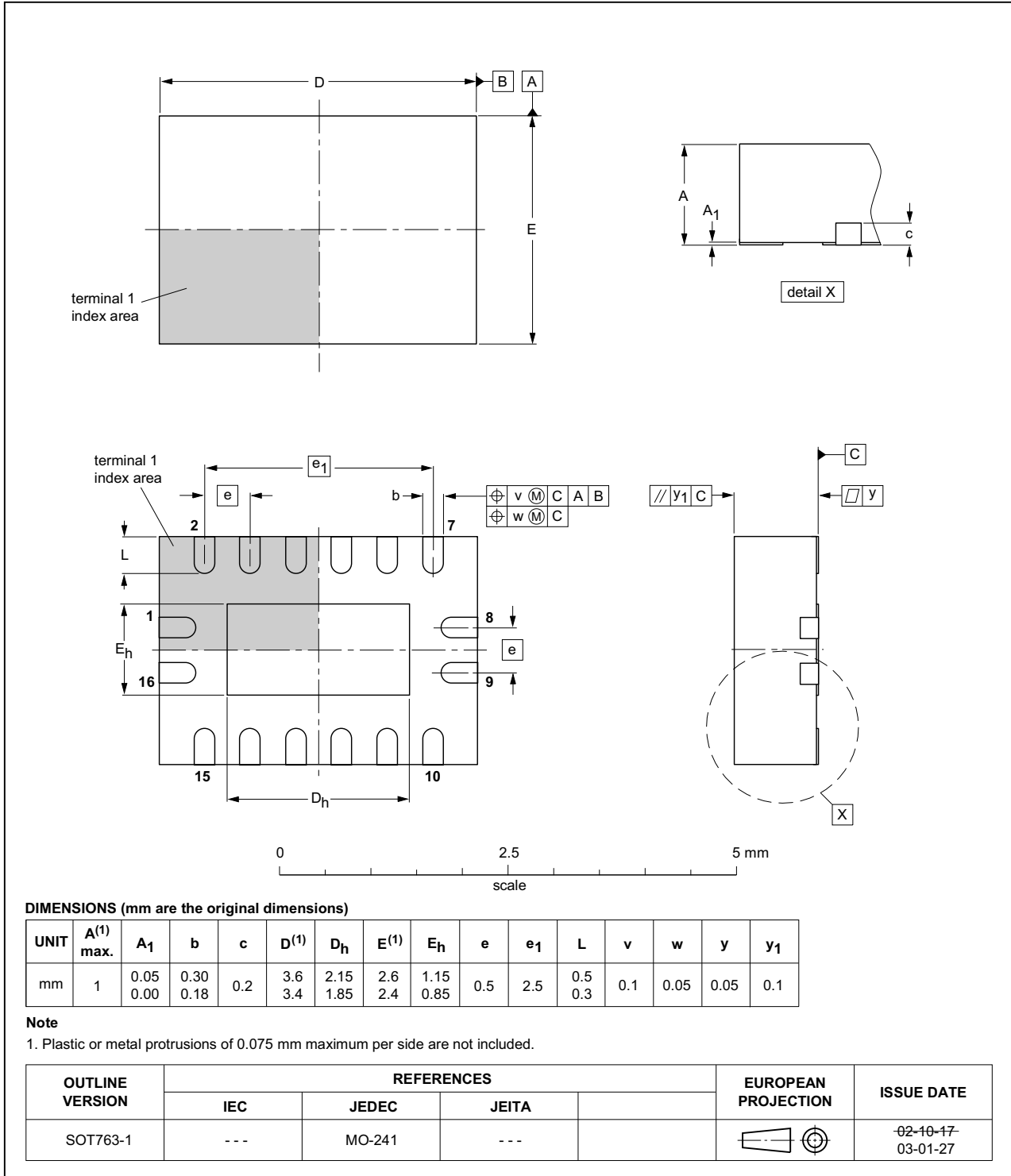


Fig 12. Package outline SOT763-1 (DHVQFN16)

13. Abbreviations

Table 10. Abbreviations

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

14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT238 v.4	20160127	Product data sheet	-	74HC_HCT238 v.3
Modifications:	<ul style="list-style-type: none"> Type numbers 74HC238N and 74HCT238N (SOT38-4) removed. 			
74HC_HCT238 v.3	20070716	Product data sheet	-	74HC_HCT238_CNV v.2
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. Legal texts have been adapted to the new company name where appropriate. Added type number 74HC238BQ and 74HCT238BQ (DHVQFN16 package) 			
74HC_HCT238_CNV v.2	19970828	Product specification	-	-

15. Legal information

15.1 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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16. Contact information

For more information, please visit: <http://www.nexperia.com>

For sales office addresses, please send an email to: salesaddresses@nexperia.com

17. Contents

1	General description	1
2	Features and benefits	1
3	Ordering information	1
4	Functional diagram	2
5	Pinning information	4
5.1	Pinning	4
5.2	Pin description	4
6	Functional description	5
7	Limiting values	5
8	Recommended operating conditions	6
9	Static characteristics	6
10	Dynamic characteristics	8
11	Waveforms	9
12	Package outline	12
13	Abbreviations	16
14	Revision history	16
15	Legal information	17
15.1	Data sheet status	17
15.2	Definitions	17
15.3	Disclaimers	17
15.4	Trademarks	18
16	Contact information	18
17	Contents	19