

# 74HC138; 74HCT138

3-to-8 line decoder/demultiplexer; inverting

Product data sheet

## 1. General description

The 74HC138; 74HCT138 is a high-speed Si-gate CMOS device and is pin compatible with Low-power Schottky TTL (LSTTL).

The 74HC138; 74HCT138 decoder accepts three binary weighted address inputs (A0, A1 and A2) and when enabled, provides 8 mutually exclusive active LOW outputs ( $\bar{Y}0$  to  $\bar{Y}7$ ).

The 74HC138; 74HCT138 features three enable inputs: two active LOW ( $\bar{E}1$  and  $\bar{E}2$ ) and one active HIGH (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 of the 74HC138; 74HCT138 to a 1-of-32 (5 lines to 32 lines) decoder with just four 74HC138; 74HCT138 ICs and one inverter.

The 74HC138; 74HCT138 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. Not used enable inputs must be permanently tied to their appropriate active HIGH- or LOW-state.

The 74HC138; 74HCT138 is identical to the 74HC238; 74HCT238 but has inverting outputs.

## 2. Features

- Demultiplexing capability
- Multiple input enable for easy expansion
- Complies with JEDEC standard no. 7A
- Ideal for memory chip select decoding
- Active LOW mutually exclusive outputs
- ESD protection:
  - ◆ HBM EIA/JESD22-A114-C exceeds 2000 V
  - ◆ MM EIA/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  $+125\text{ }^{\circ}\text{C}$

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### 3. Quick reference data

**Table 1: Quick reference data**
*GND = 0 V; T<sub>amb</sub> = 25 °C; t<sub>r</sub> = t<sub>f</sub> = 6 ns.*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>74HC138</b>						
t <sub>PHL</sub> , t <sub>PLH</sub>	propagation delay An to $\bar{Y}_n$ E3 to $\bar{Y}_n$ $\bar{E}_n$ to $\bar{Y}_n$	V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	12 14 14	-	ns
C <sub>i</sub>	input capacitance		-	3.5	-	pF
C <sub>PD</sub>	power dissipation capacitance	V <sub>I</sub> = GND to V <sub>CC</sub>	[1]	67	-	pF
<b>74HCT138</b>						
t <sub>PHL</sub> , t <sub>PLH</sub>	propagation delay An to $\bar{Y}_n$ E3 to $\bar{Y}_n$ $\bar{E}_n$ to $\bar{Y}_n$	V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	17 19 19	-	ns
C <sub>i</sub>	input capacitance		-	3.5	-	pF
C <sub>PD</sub>	power dissipation capacitance	V <sub>I</sub> = GND to (V <sub>CC</sub> - 1.5 V)	[1]	67	-	pF

[1] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> 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<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of the outputs.

### 4. Ordering information

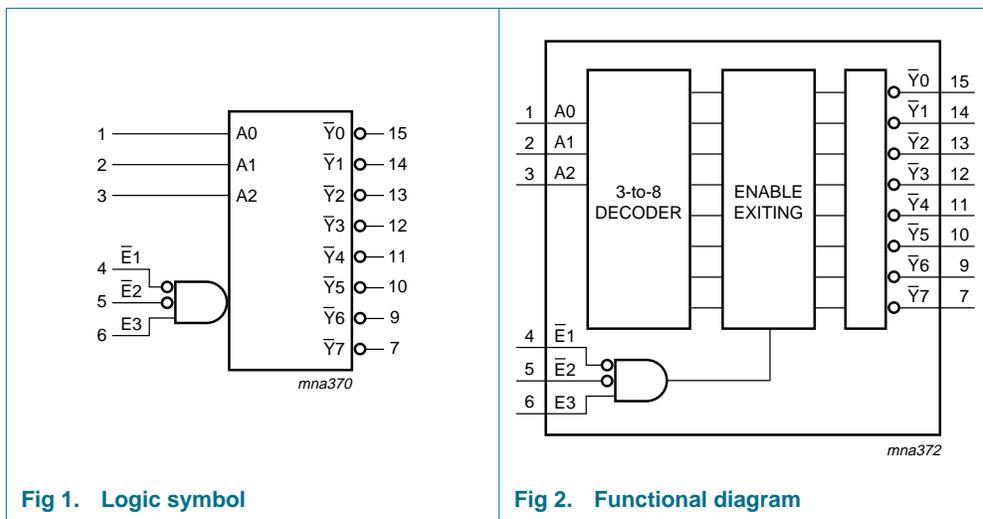
**Table 2: Ordering information**

Type number	Package			Version
	Temperature range	Name	Description	
<b>74HC138</b>				
74HC138N	-40 °C to +125 °C	DIP16	plastic dual in-line package; 16 leads (300 mil); long body	SOT38-1
74HC138D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC138DB	-40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HC138PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HC138BQ	-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

Table 2: Ordering information ...continued

Type number	Package			Version
	Temperature range	Name	Description	
<b>74HCT138</b>				
74HCT138N	-40 °C to +125 °C	DIP16	plastic dual in-line package; 16 leads (300 mil); long body	SOT38-1
74 HCT138D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT138DB	-40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HCT138PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT138BQ	-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

## 5. Functional diagram



## 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	+7	V
$I_{IK}$	input clamping current	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	-	$\pm 20$	mA
$I_O$	output current	$V_O = -0.5\text{ V}$ to $(V_{CC} + 0.5\text{ V})$	-	$\pm 25$	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				
	DIP16 package		[1]	-	750 mW
	SO16 package		[2]	-	500 mW
	SSOP16 package		[3]	-	500 mW
	TSSOP16 package		[3]	-	500 mW
	DHVQFN16 package		[4]	-	500 mW

[1] For DIP16 package:  $P_{tot}$  derates linearly with 12 mW/K above 70 °C.

[2] For SO16 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.

[3] For SSOP16 and TSSOP16 packages:  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.

[4] For DHVQFN16 packages:  $P_{tot}$  derates linearly with 4.5 mW/K above 60 °C.

## 9. Recommended operating conditions

**Table 6: Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>74HC138</b>						
$V_{CC}$	supply voltage		2.0	5.0	6.0	V
$V_I$	input voltage		0	-	$V_{CC}$	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+125	°C
$t_r, t_f$	input rise and fall time	$V_{CC} = 2.0\text{ V}$	-	-	1000	ns
		$V_{CC} = 4.5\text{ V}$	-	6.0	500	ns
		$V_{CC} = 6.0\text{ V}$	-	-	400	ns
<b>74HCT138</b>						
$V_{CC}$	supply voltage		4.5	5.0	5.5	V
$V_I$	input voltage		0	-	$V_{CC}$	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+125	°C
$t_r, t_f$	input rise and fall time	$V_{CC} = 4.5\text{ V}$	-	6.0	500	ns

**Table 8: Static characteristics 74HCT138**

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>T<sub>amb</sub> = 25 °C</b>						
V <sub>IH</sub>	HIGH-state input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	1.6	-	V
V <sub>IL</sub>	LOW-state input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	-	1.2	0.8	V
V <sub>OH</sub>	HIGH-state output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.98	4.32	-	V
V <sub>OL</sub>	LOW-state output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V	-	0.0	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.26	V
I <sub>LI</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	-	-	±0.1	µA
I <sub>OZ</sub>	OFF-state output current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 5.5 V; V <sub>O</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A	-	-	±0.5	µA
I <sub>CC</sub>	quiescent supply current	V <sub>CC</sub> = 6.0 V; I <sub>O</sub> = 0 A; V <sub>I</sub> = V <sub>CC</sub> or GND	-	-	8.0	µA
ΔI <sub>CC</sub>	additional quiescent supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 4.5 V to 5.5 V; I <sub>O</sub> = 0 A				
		pin An	-	150	540	µA
		pin $\bar{E}n$	-	125	450	µA
		pin E3	-	100	360	µA
C <sub>i</sub>	input capacitance		-	3.5	-	pF
<b>T<sub>amb</sub> = -40 °C to +85 °C</b>						
V <sub>IH</sub>	HIGH-state input voltage	V <sub>CC</sub> = 4.5 to 5.5 V	2.0	-	-	V
V <sub>IL</sub>	LOW-state input voltage	V <sub>CC</sub> = 4.5 to 5.5 V	-	-	0.8	V
V <sub>OH</sub>	HIGH-state output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 4.5 V	4.4	-	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.84	-	-	V
V <sub>OL</sub>	LOW-state output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V	-	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.33	V
I <sub>LI</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	-	-	±1.0	µA
I <sub>OZ</sub>	OFF-state output current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 5.5 V; V <sub>O</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A	-	-	±5.0	µA
I <sub>CC</sub>	quiescent supply current	V <sub>CC</sub> = 5.5 V; I <sub>O</sub> = 0 A; V <sub>I</sub> = V <sub>CC</sub> or GND	-	-	80	µA
ΔI <sub>CC</sub>	additional quiescent supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 4.5 V to 5.5 V; I <sub>O</sub> = 0 A				
		pin An	-	-	675	µA
		pin $\bar{E}n$	-	-	562.5	µA
		pin E3	-	-	450	µA

**Table 8: Static characteristics 74HCT138 ...continued**

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +125 °C</b>						
V <sub>IH</sub>	HIGH-state input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	-	-	V
V <sub>IL</sub>	LOW-state input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	-	-	0.8	V
V <sub>OH</sub>	HIGH-state output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V	4.4	-	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.7	-	-	V
V <sub>OL</sub>	LOW-state output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.4	V
I <sub>LI</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	-	-	1.0	μA
I <sub>OZ</sub>	OFF-state output current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 5.5 V; V <sub>O</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A	-	-	±10.0	μA
I <sub>CC</sub>	quiescent supply current	V <sub>CC</sub> = 5.5 V; I <sub>O</sub> = 0 A; V <sub>I</sub> = V <sub>CC</sub> or GND	-	-	160	μA
ΔI <sub>CC</sub>	additional quiescent supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 4.5 V to 5.5 V; I <sub>O</sub> = 0 A				
		pin An	-	-	735	μA
		pin $\bar{E}n$	-	-	612.5	μA
		pin E3	-	-	490	μA

**Table 10: Dynamic characteristics 74HCT138**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified.  
For test circuit see [Figure 8](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b><math>T_{amb} = 25</math> °C</b>						
$t_{PHL}$ , $t_{PLH}$	propagation delay					
	An to $\bar{Y}_n$	see <a href="#">Figure 6</a>				
		$V_{CC} = 4.5$ V	-	20	35	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	17	-	ns
	E3 to $\bar{Y}_n$	see <a href="#">Figure 6</a>				
		$V_{CC} = 4.5$ V	-	18	40	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	19	-	ns
	$\bar{E}_n$ to $\bar{Y}_n$	see <a href="#">Figure 7</a>				
		$V_{CC} = 4.5$ V	-	19	40	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	19	-	ns
$t_{THL}$ , $t_{TLH}$	output transition time	see <a href="#">Figure 6</a> and <a href="#">7</a>				
		$V_{CC} = 4.5$ V	-	7	15	ns
$C_{PD}$	power dissipation capacitance	$V_I = \text{GND to } (V_{CC} - 1.5 \text{ V})$ <a href="#">[1]</a>	-	67	-	pF
<b><math>T_{amb} = -40</math> °C to <math>+85</math> °C</b>						
$t_{PHL}$ , $t_{PLH}$	propagation delay					
	An to $\bar{Y}_n$	see <a href="#">Figure 6</a>				
		$V_{CC} = 4.5$ V	-	-	44	ns
	E3 to $\bar{Y}_n$	see <a href="#">Figure 6</a>				
		$V_{CC} = 4.5$ V	-	-	50	ns
	$\bar{E}_n$ to $\bar{Y}_n$	see <a href="#">Figure 7</a>				
		$V_{CC} = 4.5$ V	-	-	50	ns
$t_{THL}$ , $t_{TLH}$	output transition time	see <a href="#">Figure 6</a> and <a href="#">7</a>				
		$V_{CC} = 4.5$ V	-	-	19	ns
<b><math>T_{amb} = -40</math> °C to <math>+125</math> °C</b>						
$t_{PHL}$ , $t_{PLH}$	propagation delay					
	An to $\bar{Y}_n$	see <a href="#">Figure 6</a>				
		$V_{CC} = 4.5$ V	-	-	53	ns
	E3 to $\bar{Y}_n$	see <a href="#">Figure 6</a>				
		$V_{CC} = 4.5$ V	-	-	60	ns
	$\bar{E}_n$ to $\bar{Y}_n$	see <a href="#">Figure 7</a>				
		$V_{CC} = 4.5$ V	-	-	60	ns
$t_{THL}$ , $t_{TLH}$	output transition time	see <a href="#">Figure 6</a> and <a href="#">7</a>				
		$V_{CC} = 4.5$ V	-	-	22	ns

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

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

$f_i$  = input frequency in MHz;

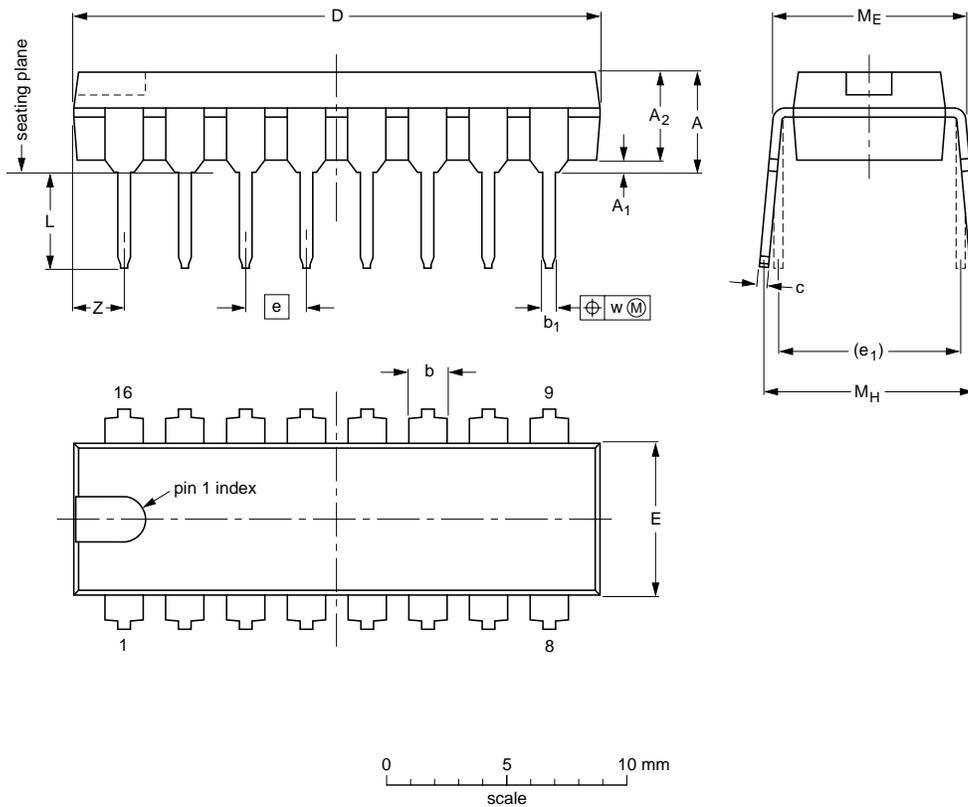
$f_o$  = output frequency in MHz;

$C_L$  = output load capacitance in pF;

13. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil); long body

SOT38-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	L	M <sub>E</sub>	M <sub>H</sub>	w	Z <sup>(1)</sup> max.
mm	4.7	0.51	3.7	1.40 1.14	0.53 0.38	0.32 0.23	21.8 21.4	6.48 6.20	2.54	7.62	3.9 3.4	8.25 7.80	9.5 8.3	0.254	2.2
inches	0.19	0.02	0.15	0.055 0.045	0.021 0.015	0.013 0.009	0.86 0.84	0.26 0.24	0.1	0.3	0.15 0.13	0.32 0.31	0.37 0.33	0.01	0.087

Note

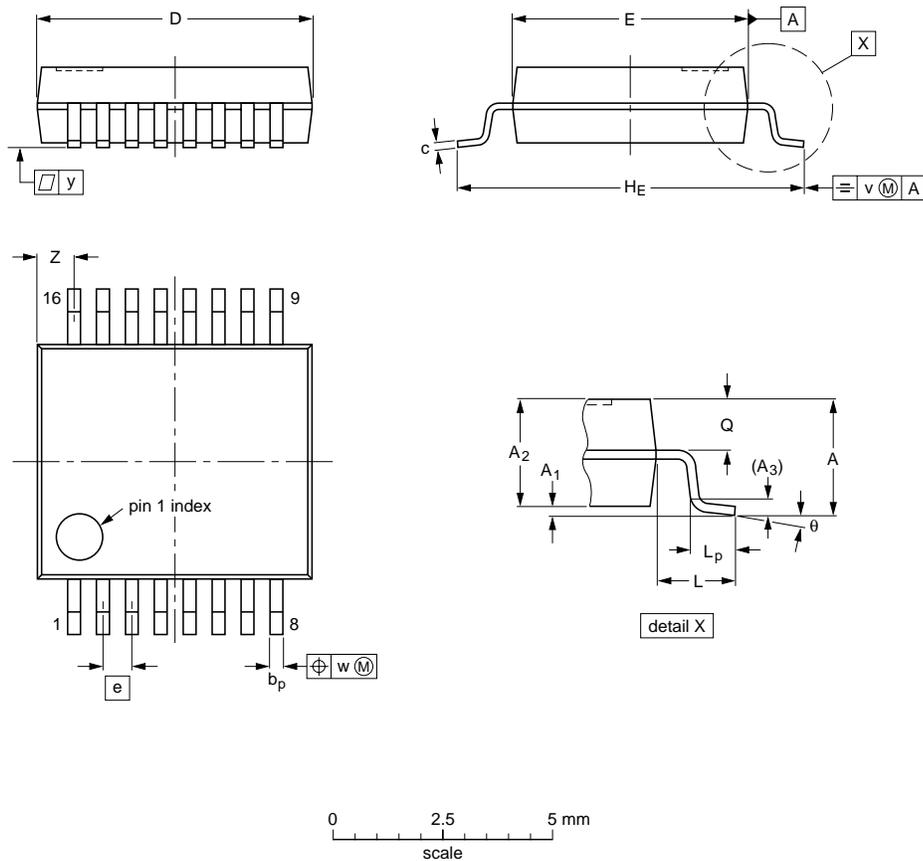
1. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION
	IEC	JEDEC	JEITA	
SOT38-1	050G09	MO-001	SC-503-16	

Fig 9. Package outline SOT38-1 (DIP16)

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

SOT338-1



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	2	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.00 0.55	8° 0°

**Note**

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

OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION
	IEC	JEDEC	JEITA	
SOT338-1		MO-150		

Fig 12. Package outline SOT338-1 (SSOP16)