



### DESCRIPTION

The AL138 is designed to be used in high-performance memory-decoding or data-routing applications requiring very short propagation delay times.

The AL138 is a 3-to-8 decoders/demultiplexers, which designed for 2V to 5.5V V<sub>CC</sub> operation.

The AL138 is consist of three enable inputs (E3,  $\bar{E}2$  and  $\bar{E}1$ ), three binary weighted address inputs (A0, A1 and A2) and eight outputs ( $\bar{Y}0$  to  $\bar{Y}7$ ).

Among all enable inputs, one is active high output enable (E3) and two are active low output enables ( $\bar{E}2$  and  $\bar{E}1$ ). When the outputs are gated by any of the strobe inputs, they are all forced into the high state. When the outputs are not disabled by the strobe inputs, only the selected output is low while all others are high.

The AL138 is available in SOP16 and TSSOP16 packages.

### ORDERING INFORMATION

Package Type	Part Number	
SOP16 SPQ: 4,000pcs/Reel	M16	AL138M16R
		AL138M16VR
TSSOP16 SPQ: 4,000pcs/Reel	TMX16	AL138TMX16R
		AL138TMX16VR
Note	V: Halogen Free Package R: Tape & Reel	
AiT provides all RoHS products		

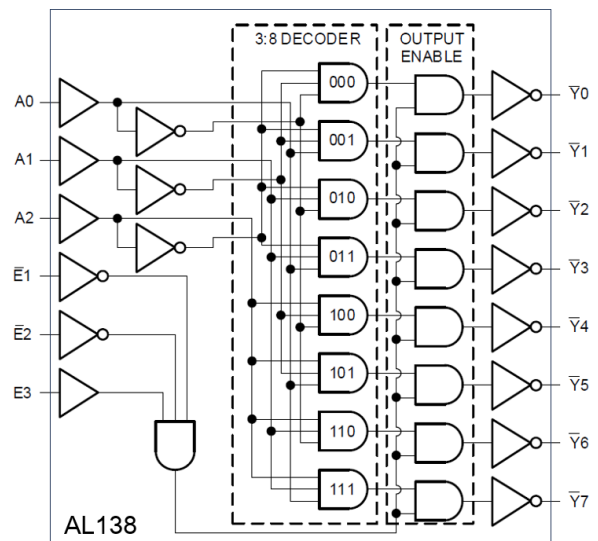
### FEATURES

- Operating Voltage Range: 2V to 5.5V
- Low Power Consumption: 160μA (Max.)
- I/O Port or Memory Selector
- Three Enable Inputs to Simplify Cascading
- Balanced Propagation Delay and Transition Times
- Operating Temperature Range: -40°C to +125°C

### APPLICATION

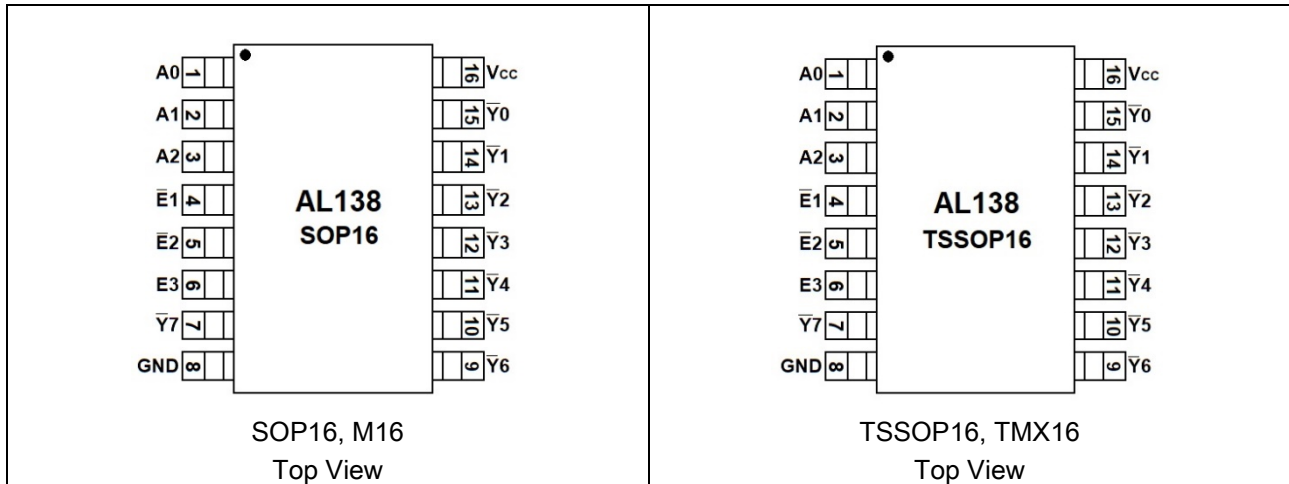
- LED Displays
- Servers
- White Goods
- Power Infrastructure
- Building Automation
- Factory Automation

### FUNCTIONAL DIAGRAM





**PIN DESCRIPTION**



Pin #		Symbol	I/O Type*	Description
SOP16	TSSOP16			
1		A0	I	Address input
2		A1	I	Address input
3		A2	I	Address input
4		$\bar{E}1$	I	Enable input (active LOW)
5		$\bar{E}2$	I	Enable input (active LOW)
6		E3	I	Enable input (active HIGH)
7		$\bar{Y}7$	O	Output
8		GND	-	Ground
9		$\bar{Y}6$	O	Output
10		$\bar{Y}5$	O	Output
11		$\bar{Y}4$	O	Output
12		$\bar{Y}3$	O	Output
13		$\bar{Y}2$	O	Output
14		$\bar{Y}1$	O	Output
15		$\bar{Y}0$	O	Output
16		Vcc	-	Power Supply

\*I=Input, O=Output.



**FUNCTION TABLE**

Enable Inputs			Address Inputs			Outputs							
E3	$\bar{E}2$	$\bar{E}1$	A2	A1	A0	$\bar{Y}0$	$\bar{Y}1$	$\bar{Y}2$	$\bar{Y}3$	$\bar{Y}4$	$\bar{Y}5$	$\bar{Y}6$	$\bar{Y}7$
X	H	X	X	X	X	H	H	H	H	H	H	H	H
X	X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	L	H	H	H	H	H	L	H	H	H	H
H	L	L	H	L	L	H	H	H	H	L	H	H	H
H	L	L	H	L	H	H	H	H	H	H	L	H	H
H	L	L	H	H	L	H	H	H	H	H	H	L	H
H	L	L	H	H	H	H	H	H	H	H	H	H	L

H: High Voltage Level  
L: Low Voltage Level  
X: Don't care

**ABSOLUTE MAXIMUM RATINGS**Over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

V <sub>CC</sub> , Supply Voltage Range		-0.5V~+7V
I <sub>IK</sub> , Input Clamp Diode Current	For V <sub>I</sub> < 0.5V or V <sub>I</sub> > V <sub>CC</sub> + 0.5V	±20mA
I <sub>OK</sub> , Output Clamp Diode Current	For V <sub>O</sub> < -0.5V or V <sub>O</sub> > V <sub>CC</sub> + 0.5V	±20mA
I <sub>O</sub> , Output Source or Sink Current Per Output Pin	For V <sub>O</sub> > -0.5V or V <sub>O</sub> < V <sub>CC</sub> + 0.5V	±25mA
Continuous Current Through V <sub>CC</sub> or GND		±50mA
I <sub>GND</sub> , Ground Current		-70mA
θ <sub>JA</sub> , Package Thermal Impedance <sup>(2)</sup>	SOP16	150°C/W
	TSSOP16	45°C/W
T <sub>J</sub> , Junction Temperature <sup>(3)</sup>		-65°C ~ +150°C
T <sub>STG</sub> , Storage Temperature		-65°C ~ +150°C
Lead Temperature (Soldering 10s) (SOIC - Lead Tips Only) 300 °C		+300°C
ESD Ratings		
V <sub>(ESD)</sub> , Electrostatic Discharge	Human-Body Model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(4)</sup>	±2000V
	Charged-Device Model (CDM), per ANSI/ESDA/JEDEC JS-002 <sup>(5)</sup>	±1000V
	Machine Model (MM)	±200V

Stresses above may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the Electrical Characteristics is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

- (1) The input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
- (2) The package thermal impedance is calculated in accordance with JEDEC-51.
- (3) The maximum power dissipation is a function of T<sub>J(MAX)</sub>, R<sub>θJA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any ambient temperature is PD = (T<sub>J(MAX)</sub> - T<sub>A</sub>) / R<sub>θJA</sub>. All numbers apply for packages soldered directly onto a PCB.
- (4) JEDEC document JEP155 states that 500 V HBM allows safe manufacturing with a standard ESD control process.
- (5) JEDEC document JEP157 states that 250 V CDM allows safe manufacturing with a standard ESD control process.



## RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	V <sub>CC</sub>		2.0	-	5.5	V
Input Voltage	V <sub>I</sub>		0	-	V <sub>CC</sub>	V
Output Voltage	V <sub>O</sub>		0	-	V <sub>CC</sub>	V
Input Rise and Fall Time	t <sub>t</sub>	V <sub>CC</sub> =2.0V	-	-	1000	ns
		V <sub>CC</sub> =4.5V	-	-	500	
		V <sub>CC</sub> =5.5V	-	-	400	
Operating Temperature	T <sub>A</sub>		-40	-	125	°C

All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation.

## SWITCHING CHARACTERISTICS

Input t<sub>t</sub> = 6ns.

Parameter	Test Conditions	V <sub>CC</sub>	Operating free-air temperature (T <sub>A</sub> )									Unit	
			25°C			-40°C to 85°C			-40°C to 125°C				
			Min. <sup>(1)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(1)</sup>	Min. <sup>(1)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(1)</sup>	Min. <sup>(1)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(1)</sup>		
t <sub>pd</sub>	Address to output C <sub>L</sub> = 50pF	2.0	-	-	51	-	-	54	-	-	55	ns	
		4.5	-	11	16	-	-	18	-	-	19		
		5.5	-	-	14	-	-	16	-	-	17		
t <sub>pd</sub>	Strobe $\bar{E}1, \bar{E}2,$ E3 to output AL138 C <sub>L</sub> = 50pF	2.0	-	-	46	-	-	49	-	-	50	ns	
		4.5	-	-	14	-	-	15	-	-	16		
		5.5	-	-	12	-	-	13	-	-	14		
t <sub>t</sub>	Output Transition Time C <sub>L</sub> = 50pF	2.0	-	-	39	-	-	41	-	-	46	ns	
		4.5	-	-	14	-	-	16	-	-	17		
		5.5	-	-	12	-	-	13	-	-	15		
C <sub>PD</sub>	Power Dissipation Capacitance <sup>(3)</sup>	C <sub>L</sub> = 15pF	5.0	-	67	-	-	-	-	-	-	pF	
C <sub>i</sub>	Input Capacitance	-	-	-	-	10	-	-	10	-	-	10	pF

All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation.

(1) This parameter is ensured by design and/or characterization and is not tested in production.

(2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

(3) CPD is used to determine the dynamic power consumption, per gate.



**ELECTRICAL CHARACTERISTICS**

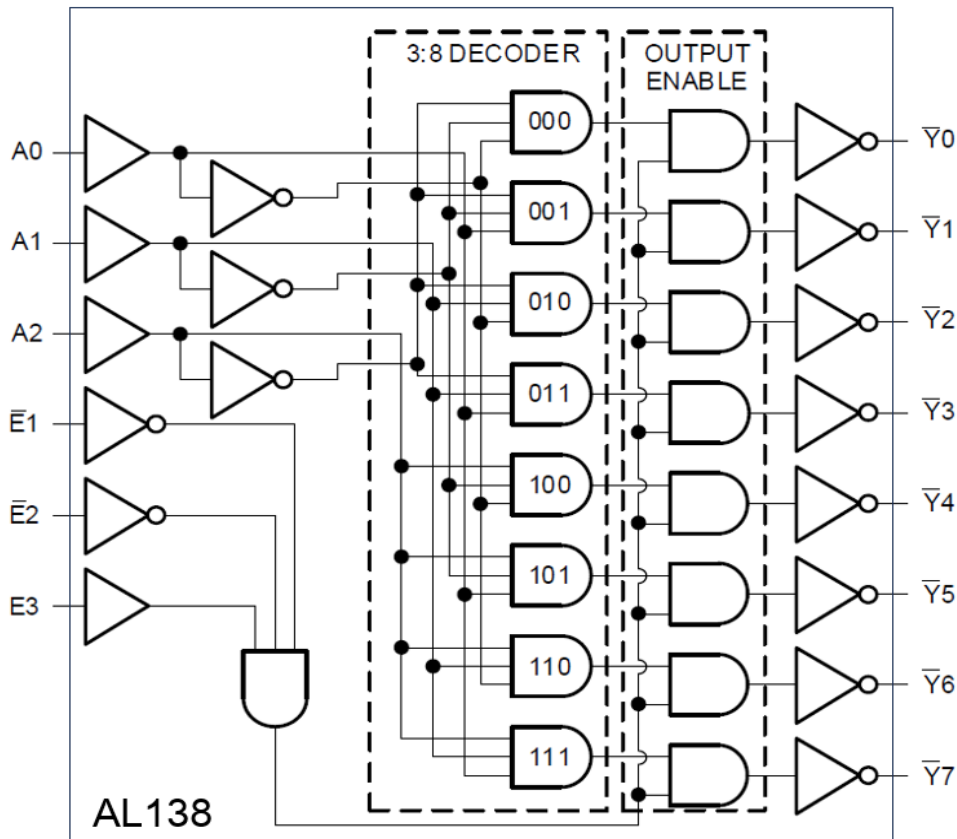
Parameter	Test Conditions <sup>(3)</sup>	V <sub>CC</sub>	Operating free-air temperature (T <sub>A</sub> )									Unit
			25°C			-40°C to 85°C			-40°C to 125°C			
			Min. <sup>(1)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(1)</sup>	Min. <sup>(1)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(1)</sup>	Min. <sup>(1)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(1)</sup>	
V <sub>IH</sub>	-	2.0	1.50	-	-	1.50	-	-	1.50	-	-	V
		4.5	3.15	-	-	3.15	-	-	3.15	-	-	
		5.5	3.85	-	-	3.85	-	-	3.85	-	-	
V <sub>IL</sub>	-	2.0	-	-	0.50	-	-	0.50	-	-	0.50	V
		4.5	-	-	1.35	-	-	1.35	-	-	1.35	
		5.5	-	-	1.65	-	-	1.65	-	-	1.65	
V <sub>OH</sub>	I <sub>OH</sub> = -20μA	2.0	1.90	-	-	1.90	-	-	1.90	-	-	V
	I <sub>OH</sub> = -20μA	4.5	4.40	-	-	4.40	-	-	4.40	-	-	
	I <sub>OH</sub> = -20μA	5.5	5.40	-	-	5.40	-	-	5.40	-	-	
	I <sub>OH</sub> = -4mA	4.5	3.98	-	-	3.84	-	-	3.70	-	-	
	I <sub>OH</sub> = -5.2mA	5.5	4.95	-	-	4.81	-	-	4.67	-	-	
V <sub>OL</sub>	I <sub>OL</sub> = 20μA	2.0	-	-	0.10	-	-	0.10	-	-	0.10	V
	I <sub>OL</sub> = 20μA	4.5	-	-	0.10	-	-	0.10	-	-	0.10	
	I <sub>OL</sub> = 20μA	5.5	-	-	0.10	-	-	0.10	-	-	0.10	
	I <sub>OL</sub> = 4mA	4.5	-	-	0.26	-	-	0.33	-	-	0.40	
	I <sub>OL</sub> = 5.2mA	5.5	-	-	0.26	-	-	0.33	-	-	0.40	
I <sub>I</sub>	V <sub>I</sub> = V <sub>CC</sub> or	5.5	-	-	±0.1	-	-	±1.0	-	-	±1.0	μA
I <sub>CC</sub>	GND	5.5	-	-	8.00	-	-	80	-	-	160	μA

All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation.

- (1) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
- (2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.
- (3) V<sub>I</sub> = V<sub>IH</sub> or V<sub>IL</sub>, unless otherwise noted.



## BLOCK DIAGRAM



## DETAILED INFORMATION

The AL138 device is 3-to-8 decoders/demultiplexers. The three address input pins, A0, A1, and A2, select which output is active. The selected output is pulled LOW, while the remaining outputs are all HIGH. The conditions at the binary weighted inputs at the three enable inputs select one of eight output lines. The three enable input pins, E3,  $\bar{E}2$  and  $\bar{E}1$ . One active high enable and two active low enable pins are available, and any enable pin can be deactivated to force all outputs high. All three enable pins must be active for the output to be enabled.

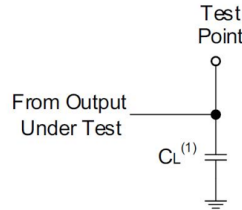
### Power Supply Recommendations

The power supply pin should have a good bypass capacitor to prevent power disturbance. For devices with a single supply, a 0.1uF capacitor is recommended and if there are multiple  $V_{CC}$  terminals then 0.01uF or 0.022uF capacitors are recommended for each power terminal. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. The 0.1uF and 1uF capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible.



### Parameter Measurement Information

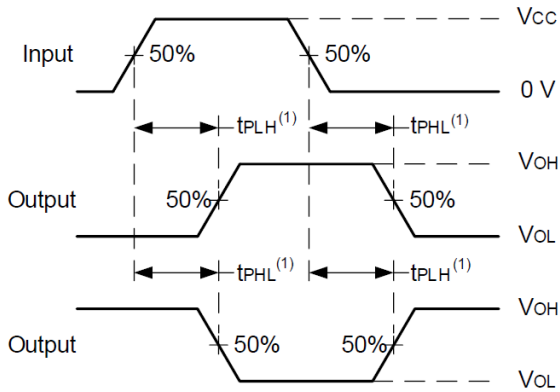
Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: PRR  $\leq 1$  MHz,  $Z_o = 50 \Omega$ ,  $t_r < 6$  ns. For clock inputs,  $f_{max}$  is measured when the input duty cycle is 50%. The outputs are measured one at a time with one input transition per measurement.



$C_L$  includes probe and test-fixtue capacitance.

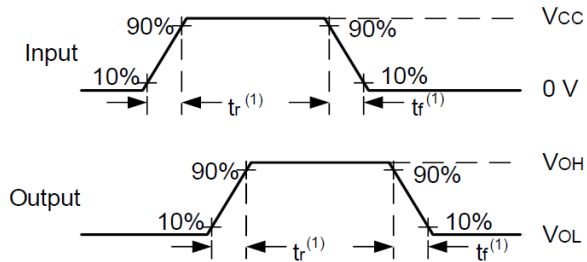
**Fig 1. Load Circuit for Push-Pull Output**

**Fig 2. Voltage Waveforms, Propagation Delays for Standard CMOS Inputs**



The greater between  $t_{PLH}$  and  $t_{PHL}$  is the same as  $t_{pd}$

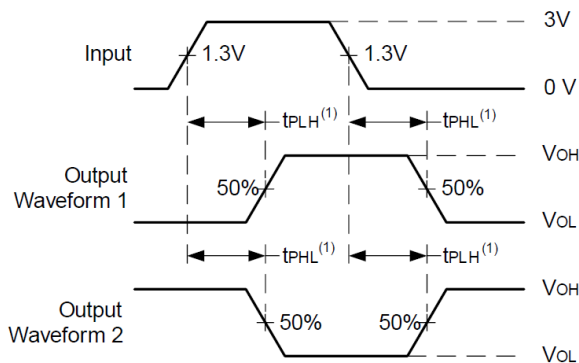
**Fig 3. Voltage Waveforms, Input and Output Transition Times for Standard CMOS Inputs**



The greater between  $t_r$  and  $t_f$  is the same as  $t_t$

**Fig 4. Voltage Waveforms, Propagation Delays for TTL-Compatible Inputs**

The greater between  $t_{PLH}$  and  $t_{PHL}$  is the same as  $t_{pd}$

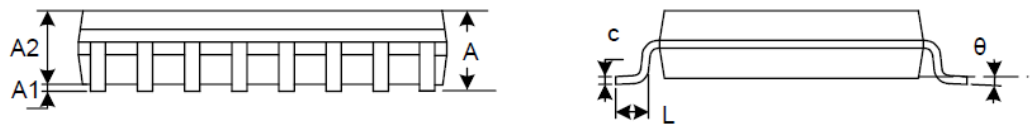
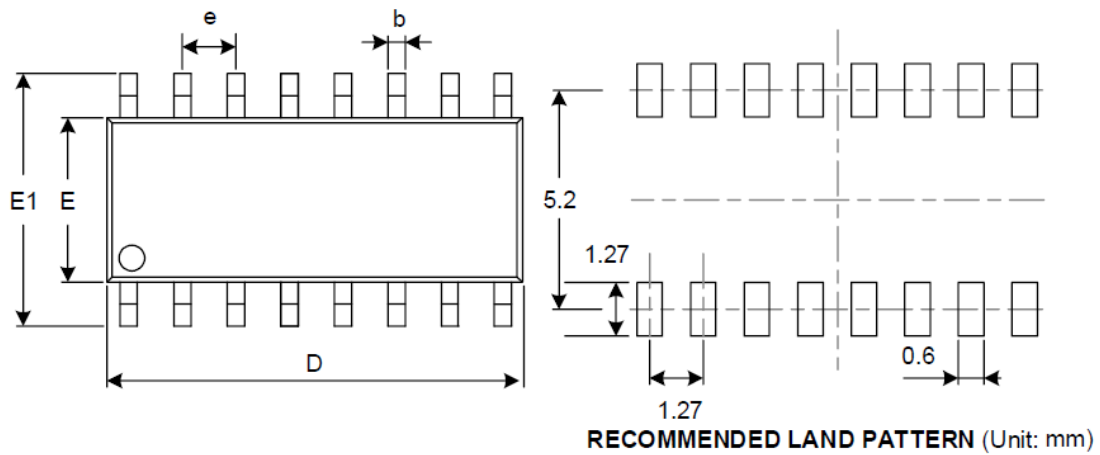






**PACKAGE INFORMATION**

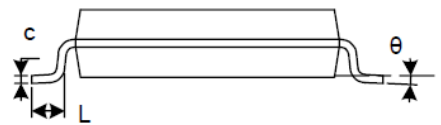
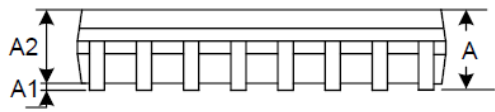
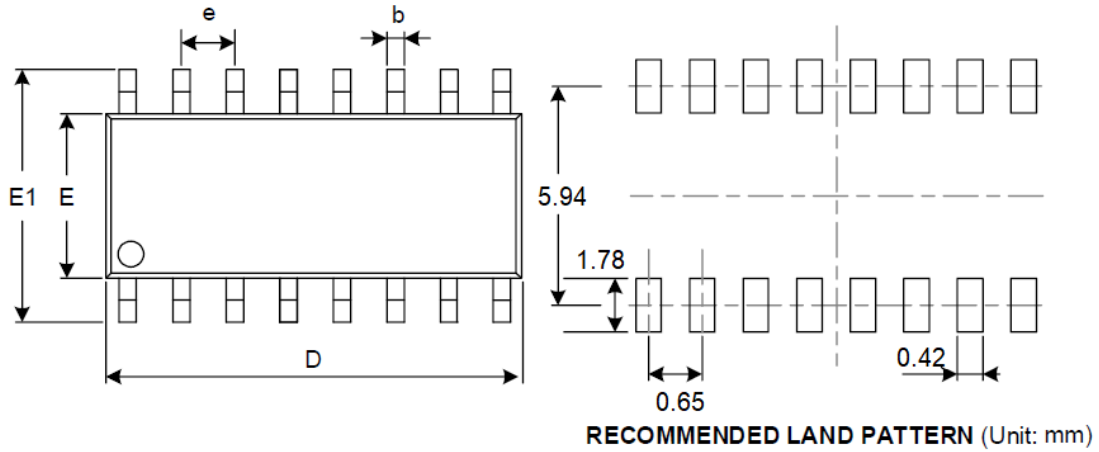
Dimension in SOP16 (Unit: mm)



Symbol	Min.	Max.
A	1.350	1.750
A1	0.100	0.250
A2	1.250	1.500
b	0.330	0.510
c	0.170	0.250
D	9.800	10.200
E	3.800	4.000
E1	5.800	6.200
e	1.270 BSC	
L	0.400	1.270
θ	0°	8°



Dimension in TSSOP16 Package (Unit: mm)



Symbol	Min.	Max.
A	-	1.200
A1	0.050	0.150
A2	0.800	1.050
b	0.190	0.300
c	0.090	0.200
D	4.860	5.100
E	4.300	4.500
E1	6.200	6.600
e	0.650 BSC	
L	0.500	0.700
$\theta$	0°	7°



## IMPORTANT NOTICE

AiT Semiconductor Inc. (AiT) reserves the right to make changes to any its product, specifications, to discontinue any integrated circuit product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

AiT Semiconductor Inc.'s integrated circuit products are not designed, intended, authorized, or warranted to be suitable for use in life support applications, devices or systems or other critical applications. Use of AiT products in such applications is understood to be fully at the risk of the customer. As used herein may involve potential risks of death, personal injury, or serve property, or environmental damage. In order to minimize risks associated with the customer's applications, the customer should provide adequate design and operating safeguards.

AiT Semiconductor Inc. assumes to no liability to customer product design or application support. AiT warrants the performance of its products of the specifications applicable at the time of sale.