

1. General Description

EM74AHC1G09 and EM74AHCT1G09 are single 2-input AND gates with open-drain outputs. Inputs are overvoltage tolerant. This feature allows the use of these devices as translators in mixed voltage environments.

2. Features and Benefits

- Wide supply voltage range from 2.0 V to 5.5 V
- Overvoltage tolerant inputs to 5.5 V
- High noise immunity
- CMOS low power dissipation
- Latch-up performance exceeds 200 mA
- Input levels:
 - For EM74AHC1G09: CMOS level
 - For EM74AHCT1G09: TTL level
- ESD protection:
 - HBM ANSI/ESDA/JEDEC JS-001 Class 3A exceeds 7000 V
 - CDM ANSI/ESDA/JEDEC JS-002 Class C3 exceeds 2000 V
- Multiple package options

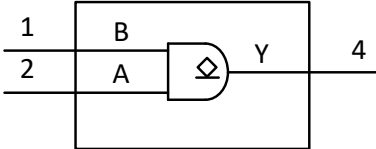
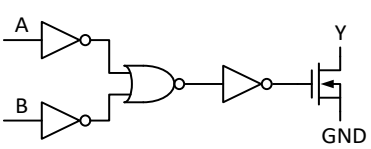
EM74AHC1G09; EM74AHCT1G09**2-input AND with open-drain output**

3. Ordering Information

Table 1. Ordering information

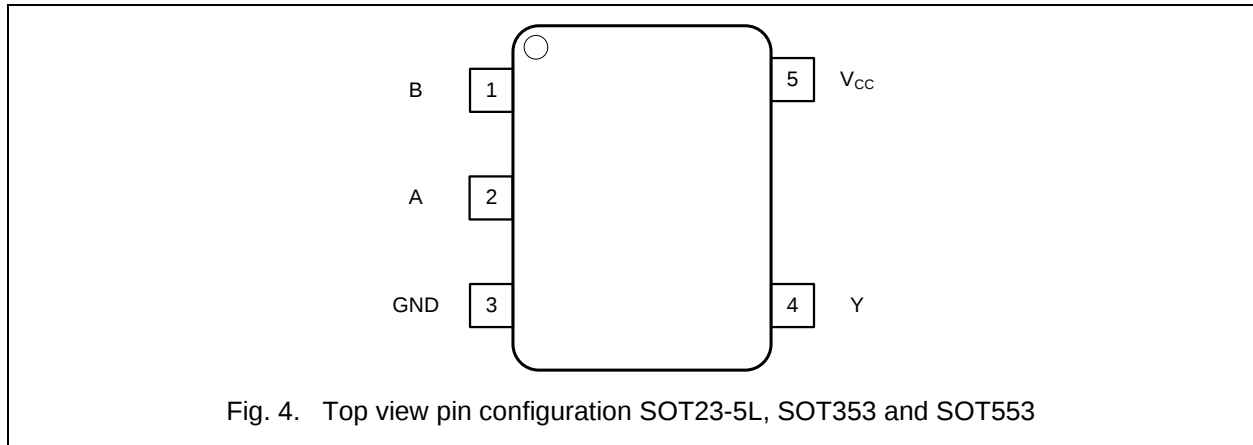
Type number	Topside marking	Package		
		Name	Description	Quantity
EM74AHC1G09GV	A7YW	SOT23-5L	SOT23 package, 5 pins 2.92 mm × 1.6 mm; 1.25 mm (Max) height	3000
EM74AHCT1G09GV	C7YW			
EM74AHC1G09GW	A7YW	SOT353	SOT353 package, 5 pins 2.1 mm × 1.25 mm; 1.1 mm (Max) height	3000
EM74AHCT1G09GW	C7YW			
EM74AHC1G09DRL	A7YW	SOT553	SOT553 package, 5 pins 1.6 mm × 1.2 mm; 0.6 mm (Max) height	3000
EM74AHCT1G09DRL	C7YW			

4. Function Diagram

 Fig. 1. Logic symbol	 Fig. 2. IEC logic symbol	 Fig. 3. Logic diagram
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5. Pinning Information

5.1. Pinning



5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
B	1	Data input
A	2	Data input
GND	3	Ground (0V)
Y	4	Data output
V _{CC}	5	Supply voltage

6. Functional Description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; Z = high-impedance OFF-state.

Input		Output
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	Z

7. Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Table 4. Absolute Maximum Ratings

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND.

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		-0.5	7.0	V
V_I	input voltage		-0.5	7.0	V
I_{IK}	input clamping current	$V_I < -0.5$ V	-20		mA
I_{OK}	output clamping current	$V_O < -0.5$ V [1]		± 20	mA
I_O	output current	$V_O > -0.5$ V		± 25	mA
V_O	output voltage	active mode [1]	-0.5	7.0	V
		high-impedance mode [1]	-0.5	7.0	V
I_{CC}	supply current			75	mA
I_{GND}	ground current		-75		mA
P_{tot}	total power dissipation	$T_{amb} = -40$ °C to $+125$ °C		250	mW
T_{stg}	storage temperature		-65	150	°C

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

8. Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. EnergyMath does not recommend exceeding them or designing to Absolute Maximum Ratings.

Table 5. Recommended Operating Conditions

Symbol	Parameter	Conditions	EM74AHC1G09			EM74AHCT1G09			Unit
			Min	Typ	Max	Min	Typ	Max	
V_{CC}	supply voltage		2.0	5.0	5.5	4.5	5.0	5.5	V
V_I	input voltage		0		5.5	0		5.5	V
V_O	output voltage	active mode	0		V_{CC}	0		V_{CC}	V
		high-impedance mode	0		6.0	0		6.0	V
T_{amb}	ambient temperature		-40	25	125	-40	25	125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 3.3$ V $\pm$ 0.3 V			100				ns/V
		$V_{CC} = 5.0$ V $\pm$ 0.5 V			20			20	ns/V

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9.Static Characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	
EM74AHC1G09								
V _{IH}	HIGH-level input voltage	V _{CC} = 2.0 V	1.5			1.5		V
		V _{CC} = 3.0 V	2.1			2.1		V
		V _{CC} = 5.5 V	3.85			3.85		V
V _{IL}	LOW-level input voltage	V _{CC} = 2.0 V			0.5		0.5	V
		V _{CC} = 3.0 V			0.9		0.9	V
		V _{CC} = 5.5 V			1.65		1.65	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}						
		I _O = 50 μA; V _{CC} = 2.0 V		0	0.1		0.1	V
		I _O = 50 μA; V _{CC} = 3.0 V		0	0.1		0.1	V
		I _O = 50 μA; V _{CC} = 4.5 V		0	0.1		0.1	V
		I _O = 4.0 mA; V _{CC} = 3.0 V		0.05	0.44		0.55	V
		I _O = 8.0 mA; V _{CC} = 4.5 V		0.07	0.44		0.55	V
I _I	input leakage current	V _I = 5.5 V or GND ; V _{CC} = 0 V to 5.5 V		±0.01	±1.0		±2.0	μA
I _{OZ}	OFF-state output current	V _I = V _{IH} or V _{IL} ; V _O = V _{CC} or GND; V _{CC} = 5.5 V		±0.01	±2.5		±10.0	μA
I _{CC}	supply current	V _I = V _{CC} or GND ; I _O = 0 A ; V _{CC} = 5.5 V		0.01	10		20	μA
C _I	input capacitance			3.5				pF

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Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	
EM74AHCT1G09								
V _{IH}	HIGH-level input voltage	V _{CC} = 4.5 V to 5.5 V	2.0			2.0		V
V _{IL}	LOW-level input voltage	V _{CC} = 4.5 V to 5.5 V			0.8		0.8	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V						
		I _O = 50 µA;		0	0.1		0.1	V
		I _O = 8.0 mA;		0.07	0.44		0.55	V
I _I	input leakage current	V _I = 5.5 V or GND ; V _{CC} = 0 V to 5.5 V		±0.01	±1.0		±2.0	µA
I _{OZ}	OFF-state output current	V _I = V _{IH} or V _{IL} ; V _O = V _{CC} or GND; V _{CC} = 5.5 V		±0.01	±2.5		±10.0	µA
I _{CC}	supply current	V _I = V _{CC} or GND ; I _O = 0 A ; V _{CC} = 5.5 V		0.01	10		20	µA
ΔI _{CC}	additional supply current	per input pin ; V _I = 3.4 V; other inputs at V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V		0.23	1.35		1.35	mA
C _I	input capacitance			3.5				pF

[1]All typical values are measured at $T_{amb} = 25^\circ\text{C}$.

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10. Dynamic Characteristics

Table 7. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 6.

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	
EM74AHC1G09								
t _{PZL}	OFF-state to LOW propagation delay	A and B to Y; see Fig. 5						
		V _{CC} = 3.0 V to 3.6 V, C _L = 15 pF	2.5	5.3	8.5	2.5	9.5	ns
		V _{CC} = 4.5 V to 5.5 V, C _L = 15 pF	1.5	3.5	5.5	1.5	6.0	ns
t _{PLZ}	LOW to OFF-state propagation delay	A and B to Y; see Fig. 5						
		V _{CC} = 3.0 V to 3.6 V, C _L = 15 pF	2.5	5.8	9.0	2.5	10.0	ns
		V _{CC} = 4.5 V to 5.5 V, C _L = 15 pF	1.5	4.1	6.0	1.5	6.5	ns
C _{PD}	power dissipation capacitance	C _L = 15 pF ; f = 1MHz ; V _I = GND to V _{CC} ; [2]		4				pF
EM74AHCT1G09								
t _{PZL}	OFF-state to LOW propagation delay	A and B to Y; see Fig. 5						
		V _{CC} = 4.5 V to 5.5 V, C _L = 15 pF	1.5	5.0	7.0	1.5	7.5	ns
t _{PLZ}	LOW to OFF-state propagation delay	A and B to Y; see Fig. 5						
		V _{CC} = 4.5 V to 5.5 V, C _L = 15 pF	1.5	5.1	7.0	1.5	7.5	ns
C _{PD}	power dissipation capacitance	C _L = 15 pF ; f = 1MHz ; V _I = GND to V _{CC} ; [2]		4				pF

[1] Typical values are measured at T_{amb} = 25 °C and V_{CC} = 3.3 V and 5.0 V respectively.

[2] 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;

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

10.1. Waveforms and test circuit

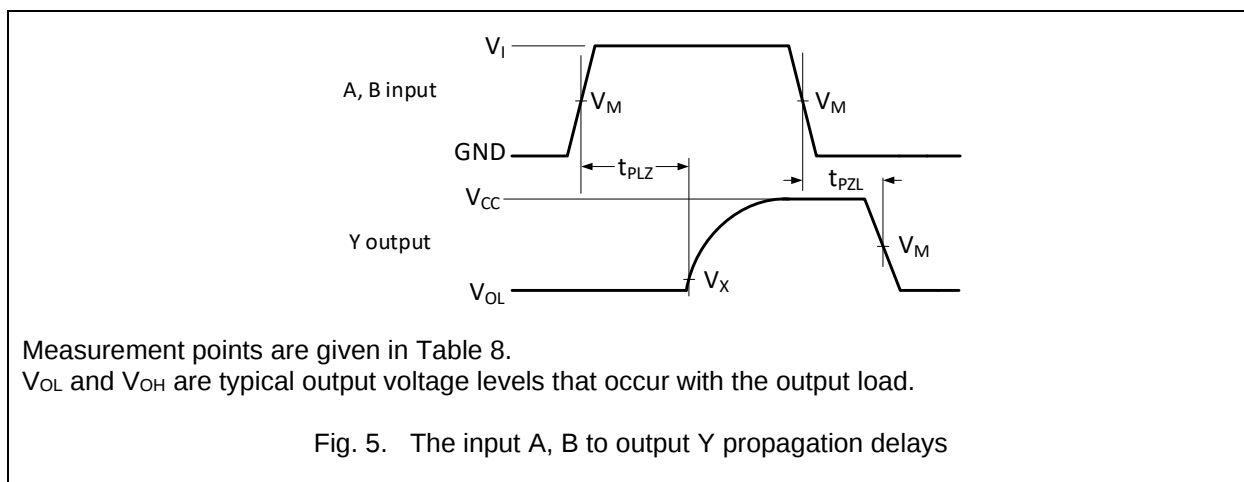
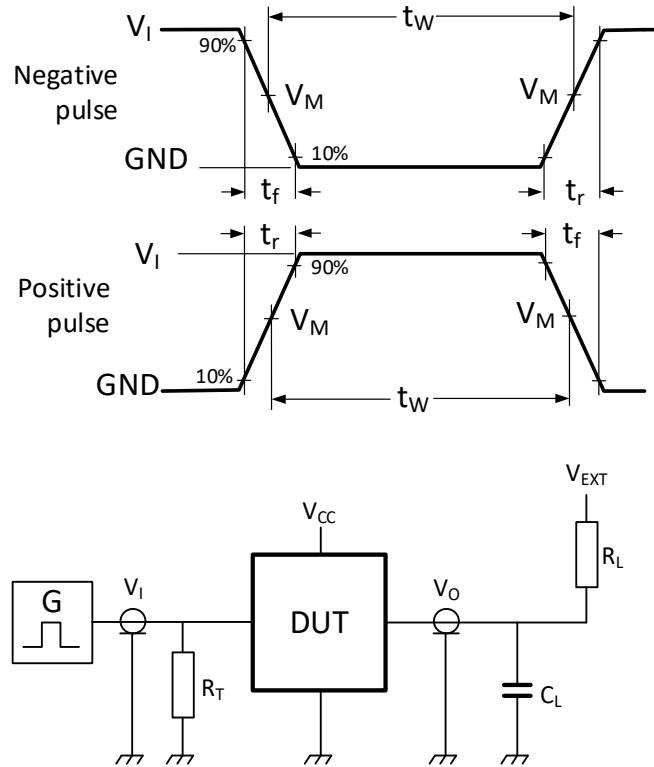


Table 8. Measurement points

Type	Input		Output	
	V_I	V_M	V_M	V_X
EM74AHC1G09	GND to V_{CC}	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	$V_{OL} + 0.3V$
EM74AHCT1G09	GND to 3.0 V	1.5 V	$0.5 \times V_{CC}$	$V_{OL} + 0.3V$

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2-input AND with open-drain output



Test data is given in Table 9.

Definitions for test circuit:

C_L = Load capacitance including jig and probe capacitance.

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

R_L = Load resistance.

V_{EXT} = External voltage for measuring switching times.

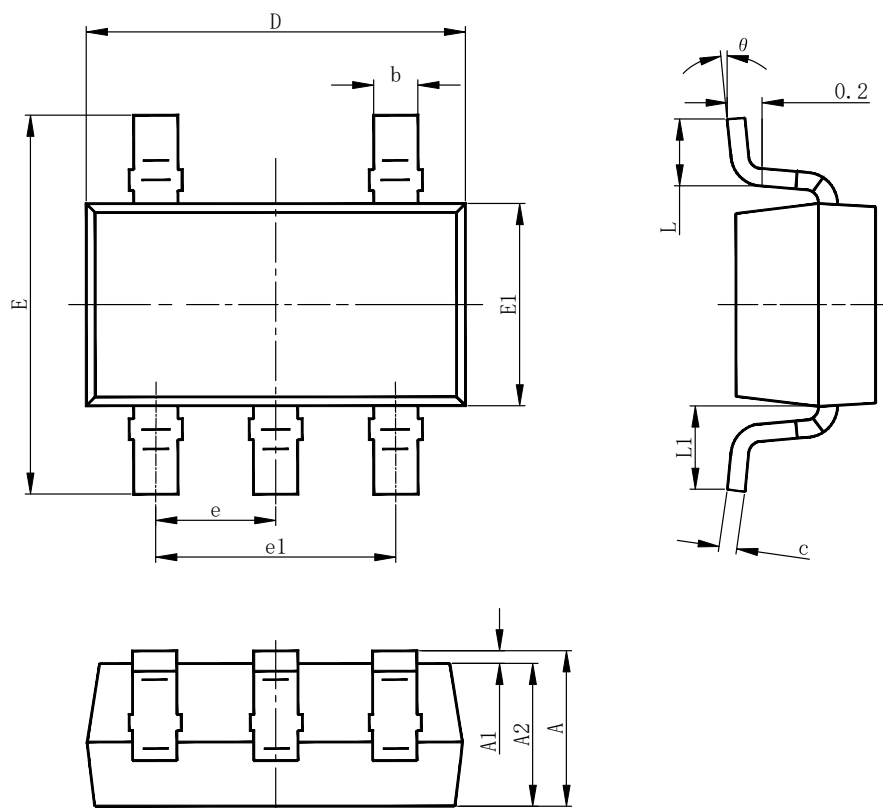
Fig. 6. Test circuit for measuring switching times

Table 9. Test data

Type	Input		Load		
	V_I	$t_r = t_f$	C_L	R_L	t_{PZL}, t_{PLZ}
EM74AHC1G09	GND to V_{CC}	≤ 2.5 ns	15 pF	500 Ω	V_{CC}
EM74AHCT1G09	GND to 3.0 V	≤ 2.5 ns	15 pF	500 Ω	V_{CC}

11. Package Outline

SOT23-5L

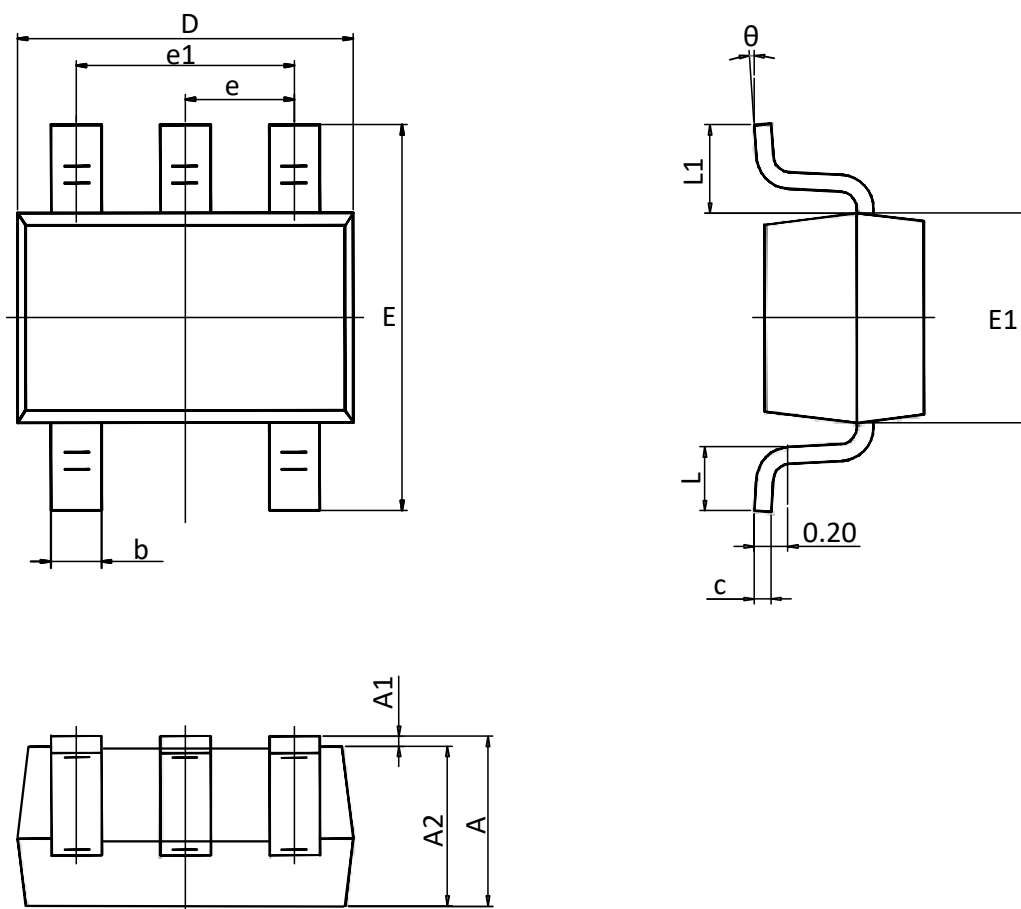


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
L1	0.600REF.		0.024REF.	
θ	0°	8°	0°	8°

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SOT353

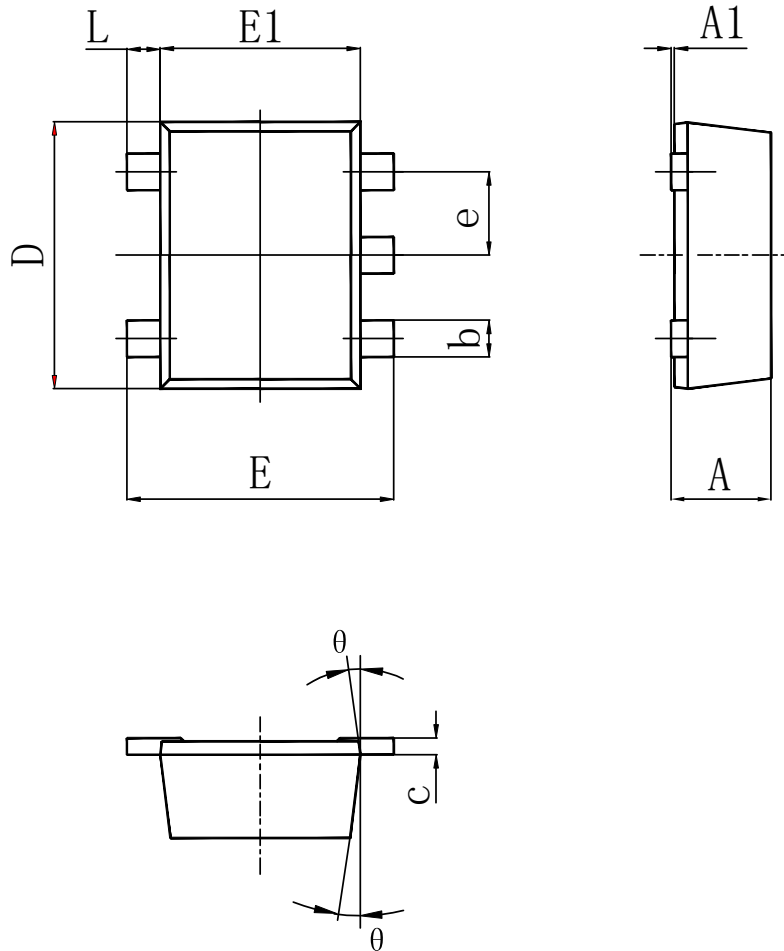


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.110	0.175	0.004	0.007
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650 TYP.		0.026 TYP.	
e1	1.200	1.400	0.047	0.055
L	0.260	0.460	0.010	0.018
L1	0.525 REF.		0.021 REF.	
θ	0°	8°	0°	8°

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2-input AND with open-drain output

SOT553



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.525	0.600	0.021	0.024
A1	0.000	0.050	0.000	0.002
e	0.450	0.550	0.018	0.022
c	0.090	0.160	0.004	0.006
D	1.500	1.700	0.059	0.067
b	0.170	0.270	0.007	0.011
E1	1.100	1.300	0.043	0.051
E	1.500	1.700	0.059	0.067
L	0.100	0.300	0.004	0.012
θ	7 °REF.		7 °REF.	

12. Abbreviations

Table 10. Abbreviations

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

13. Revision History

Table 11. Revision history

Document ID	Release Date	Data sheet status	Change notice	Supersedes
EM74AHC_AHCT1G09 Rev. 1.1	Aug 26, 2024	Product datasheet		EM74AHC_AHCT1G09 Rev. 1.0
Modifications:	- Section 2: ESD protectin HBM updated - Table 6: C_i updated. - Table 7: t_{pd} and C_{pd} updated.			
EM74AHC_AHCT1G09 Rev. 1.0	Apr 20, 2024	Product datasheet		