LM324

Quad Operational Amplifier

Description

The LM324 is a quad low-power differential operational amplifier that can be powered by a single power supply or dual power supplies. It features high open-loop gain, internal compensation, a wide common-mode input range, excellent temperature stability, and output short-circuit protection. The device operates with power supply voltages as low as 3.0V and as high as 32V. Its common-mode input range includes the negative supply, eliminating the need for external biasing, and the output voltage range also covers the negative supply voltage.

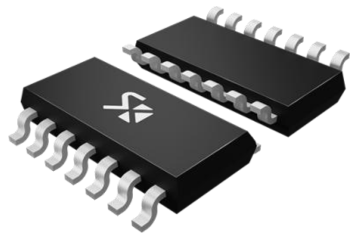
It is widely used in sensor amplifier circuits, DC amplification modules, audio amplifier circuits, and traditional operational amplifier circuits.

Available in SOP14 and DIP14 package types.

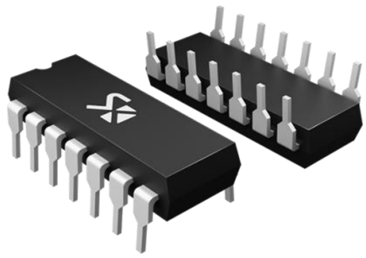
Features

- Internal frequency compensation
- Output short-circuit protection
- Four independent op-amps built-in
- Package types: SOP-14 and DIP-14
- Single power supply voltage range:3V~32V
- Dual power supply voltage range:±1.5V~±16V
- Unity-gain bandwidth:1.2MHz

Package Outline Drawing



SOP-14

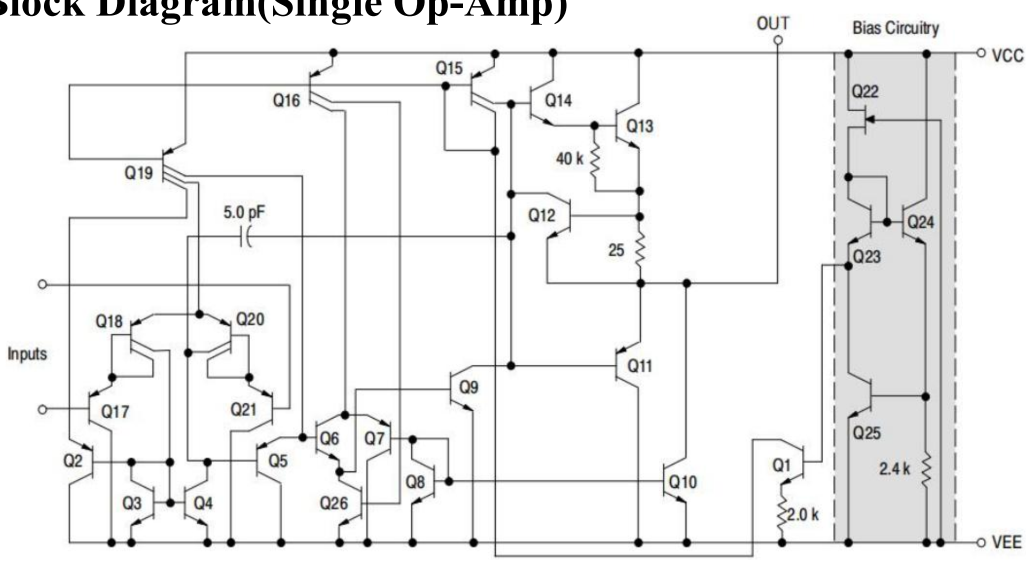


DIP-14

Application

- Sensor signal amplifiers
- DC gain circuits
- Audio amplifiers
- Other application fields

Function Block Diagram(Single Op-Amp)

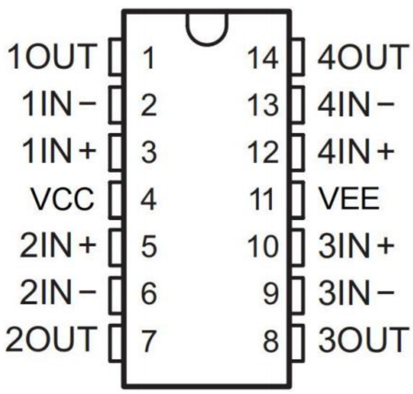


Ordering Information

Type	Marking	Package
LM324-H14	LM324	DIP-14
LM324-P14	LM324	SOP-14

Pin Description

Pin Number	Pin Name	I/O	Description	Pin Configuration
1	1OUT	O	Output of the 1st op-amp	
2	1IN-	I	Inverting input of the 1st op-amp	
3	1IN+	I	Non-inverting input of the 1st op-amp	
4	VCC	P	Positive power supply	
5	2IN+	I	Non-inverting input of the 2nd op-amp	
6	2IN-	I	Inverting input of the 2nd op-amp	
7	2OUT	O	Output of the 2nd op-amp	
8	3OUT	O	Output of the 3rd op-amp	
9	3IN-	I	Inverting input of the 3rd op-amp	
10	3IN+	I	Non-inverting input of the 3rd op-amp	
11	VEE	P	Negative power supply	
12	4IN+	I	Non-inverting input of the 4th op-amp	
13	4IN-	I	Inverting input of the 4th op-amp	
14	4OUT	O	Output of the 4th op-amp	



Absolute Maximum Ratings (T$_A$=25℃ unless otherwise noted)

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	32 or ±16	V
Differential Input Voltage	V_{ID}	±32	V
Input Voltage(Either Input)	V_I	-0.3~V_{CC}	V
Maximum Operating Junction Temperature	T_J	150	℃
Operating Ambient Temperature	T_A	-20~+85	℃
Storage Temperature	T_S	-65~+150	℃
Lead Temperature(Soldering, 10s)	T_W	260	℃

Electrical Characteristics(T_A=25℃, V_{CC}=5 V, V_{EE}=GND unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input Offset Voltage	V_{IO}	V_{CC}=5V~32V,V_{ICM}=$V_{ICM(min)}$, V_O=1.4V	-	±2	±5	mV
Input Offset Voltage	I_{IO}	V_O=1.4V	-	±10	±50	nA
Input Bias Voltage	I_B	V_O=1.4V	-	±50	±250	nA
Common-Mode Input Voltage	V_{ICM}	V_{CC}=5V~32V	V_{EE}	-	V_{CC}-1.5	V
Open-Loop Voltage Gain	A_{OL}	V_{CC}=15V,V_O=1V~11V; R_L≥10KΩ,connected to V_{EE}	-	100	-	V/mV
Common-Mode Rejection Ratio	CMRR	V_{CC}=5V~32V,V_{ICM}=$V_{ICM(min)}$	-	80	-	dB
Power Supply Rejection Ration	PSRR	V_{CC}=5V~32V,f=20KHz	-	90	-	dB
Channel Isolation	CS	f=1KHz~20KHz	-	120	-	dB
Output High-Level Voltage	V_{OH}	V_{CC}=5V,V_{ID}=1V; R_L=2KΩ	-	3.5	-	V
		V_{CC}=30V,V_{ID}=1V; R_L=2KΩ	26	-	-	V
		V_{CC}=30V,V_{ID}=1V; R_L=10KΩ	27	28	-	V
Output Low-Level Voltage	V_{OL}	V_{CC}=5V,V_{ID}=-1V; R_L=10KΩ	-	5.0	20	mV
Output Current	I_{SOURCE}	V_{CC}=15V,V_{ID}=1V,V_O=2V	-20	-35	-	mA
	I_{SINK}	V_{CC}=15V,V_{ID}=-1V,V_O=2V	10	13	-	mA
Power Supply Current	I_{CC1}	V_{CC}=15V,V_O=1/2V_{CC},No load	-	0.8	2	mA
	I_{CC2}	V_{CC}=30V,V_O=1/2V_{CC},No load	-	1.4	3	mA
Gain-Bandwidth Product	GBWP		-	1.2	-	MHz
Slew Rate	SR		-	0.5	-	V/μs

Typical Applications

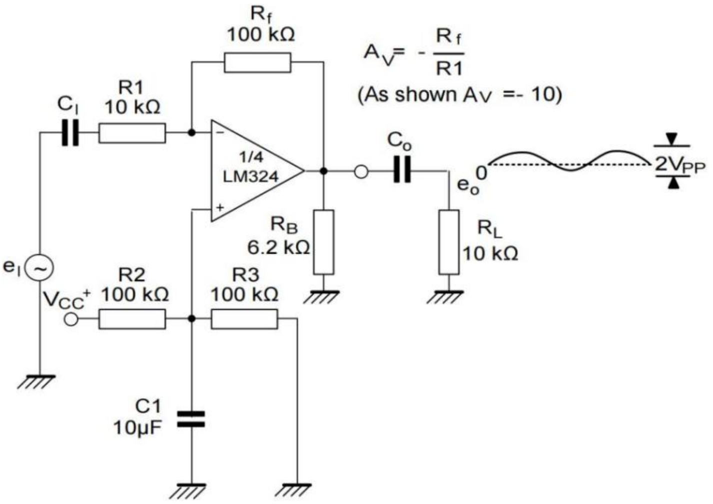


Figure 1.AC-Coupled Inverting Amplifier

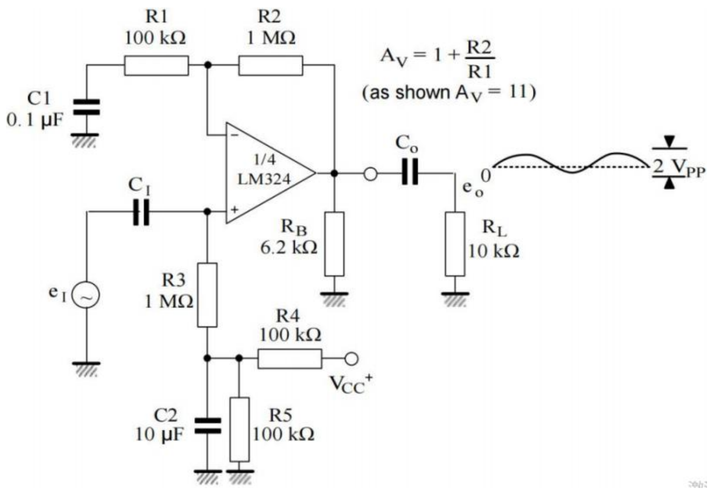


Figure 2.AC-Coupled Non-Inverting Amplifier

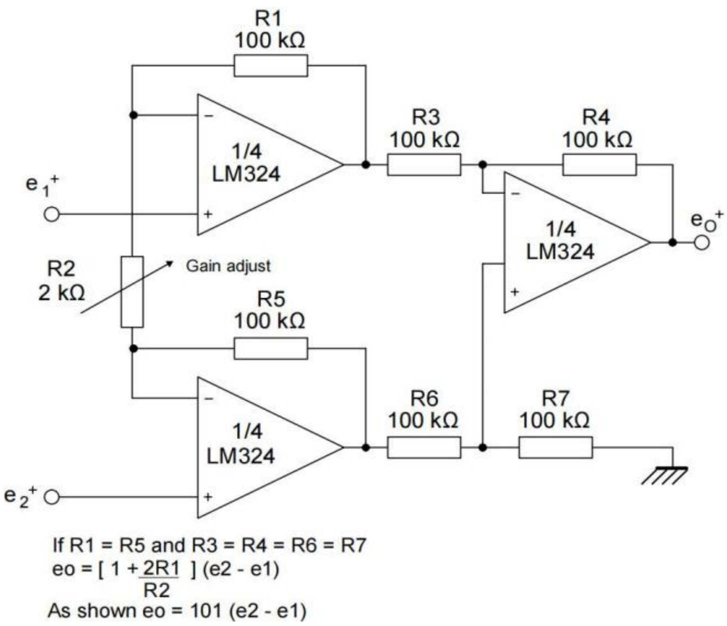


Figure 3.Adjustable Gain DC Instrumentation Amplifier(High Input Impedance)

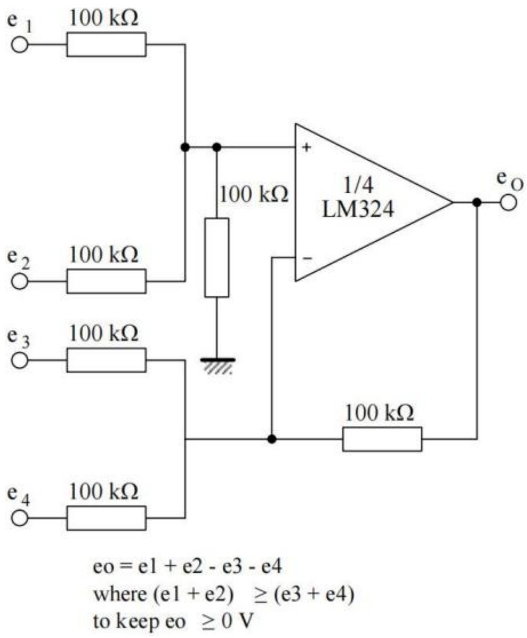


Figure 4. DC Summing Amplifier

Typical Characteristics Curves

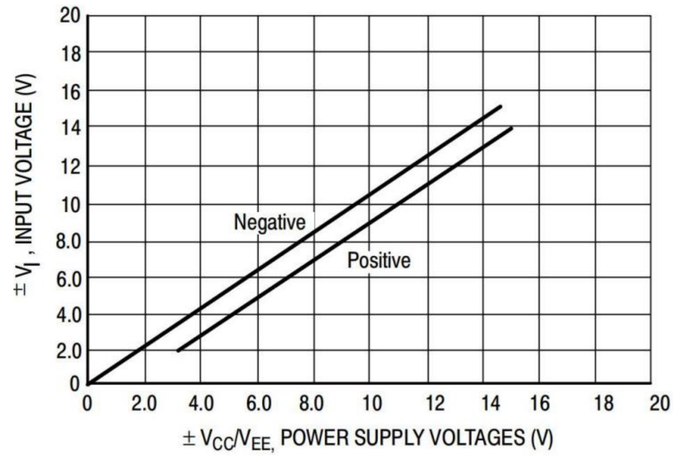


Figure 5. Relationship between Input Voltage and Power Supply Voltage

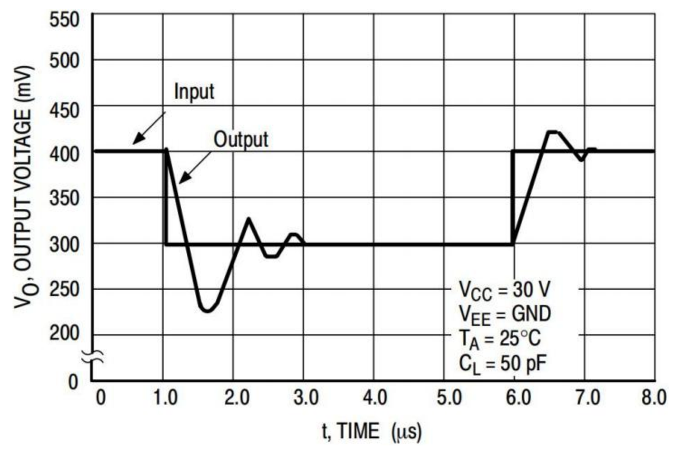


Figure 6. Small-Signal Voltage Follower Pulse Response(No-Inverting)

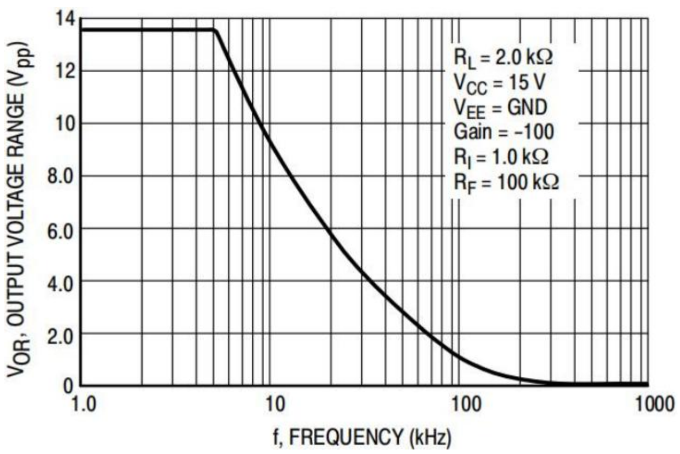


Figure 7.Large-Signal Frequency Response

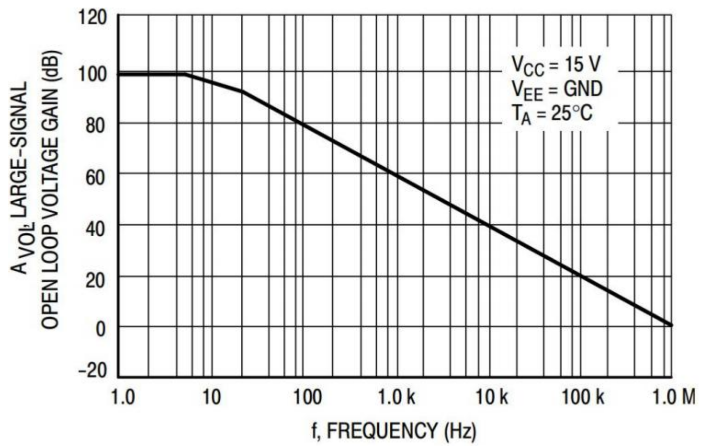


Figure 8. Relationship between Open-Loop Gain and Frequency

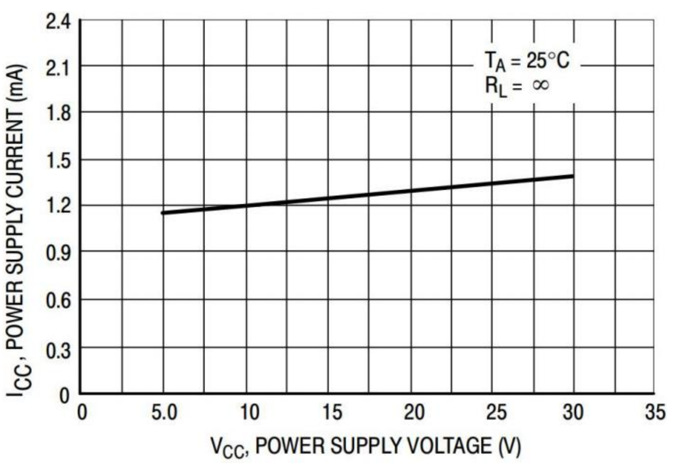


Figure 9.Relationship between Power Supply Current and Power Supply Voltage

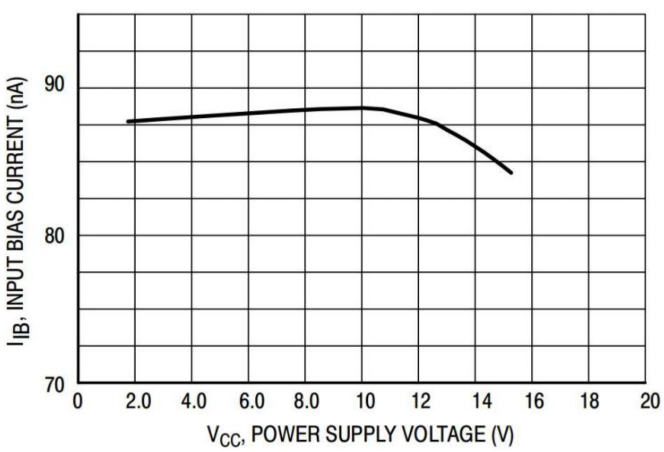
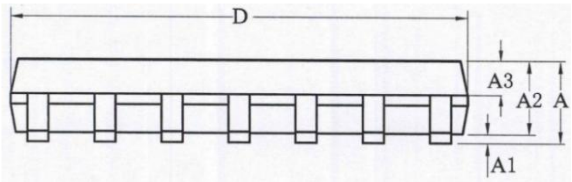


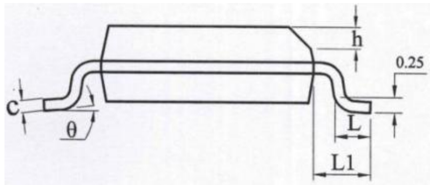
Figure 9.Relationship between Input Bias Current and Power Supply Voltage

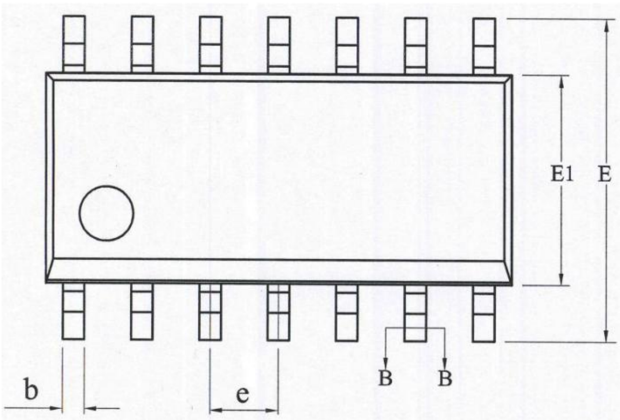
Package Information

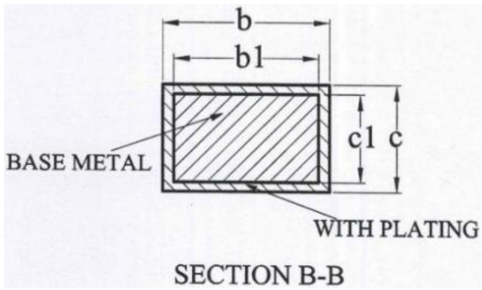
SOP-14

Dimensions in mm







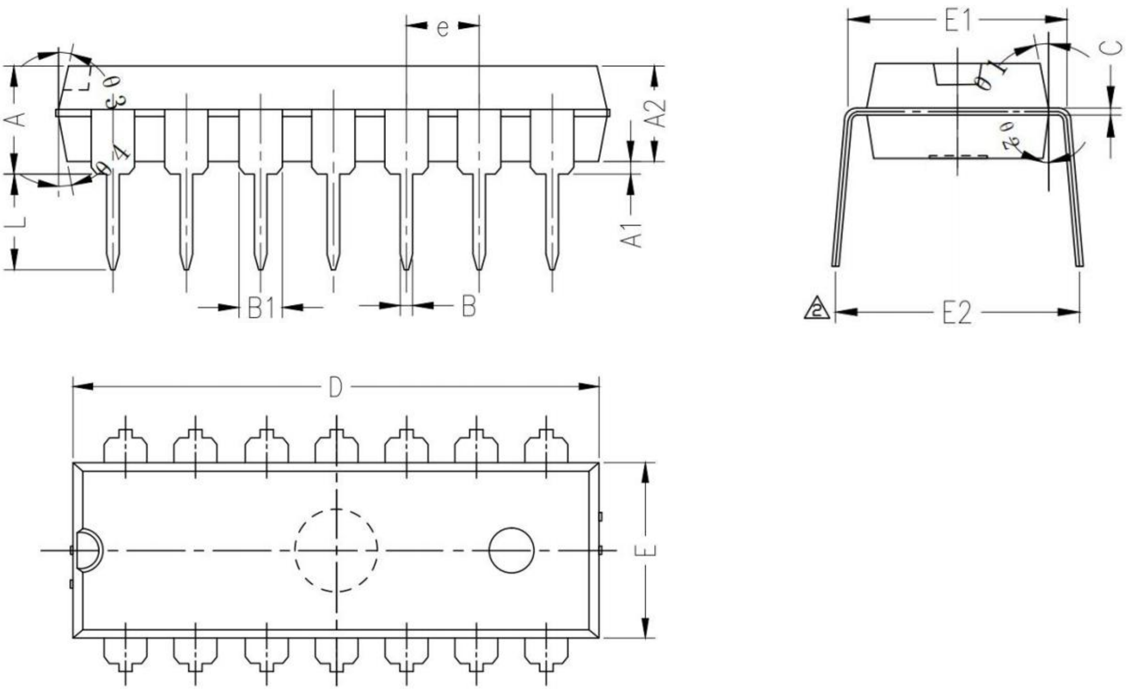


Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Nom	Max		Min	Nom	Max
A	-	-	1.75	D	8.55	8.65	8.75
A1	0.10	-	0.225	E	5.80	6.00	6.20
A2	1.30	1.40	1.50	E1	3.80	3.90	4.00
A3	0.60	0.65	0.70	e	1.27 (BSC)		
b	0.39	-	0.47	h	0.25	-	0.50
b1	0.38	0.41	0.44	L	0.50	-	0.80
c	0.20	-	0.24	L1	1.05 (REF)		
c1	0.19	0.20	0.21	θ	0°	-	8°

Package Information

DIP-14

Dimensions in mm



Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Nom	Max		Min	Nom	Max
A	3.75	3.81	3.95	E1	7.35	7.62	7.85
A1	0.51	-	-	e	2.54 (BSV)		
A2	3.20	3.30	3.45	L	3.00	3.30	3.60
B	0.38	0.48	0.56	E2	8.00	8.40	8.80
B1	1.52 (BSC)			θ1	9°	-	15°
C	0.20	0.25	0.34	θ2	7°	-	13°
D	18.80	19.05	19.30	θ3	8°	-	14°
E	6.20	6.35	6.50	θ4	5°	-	12°

Shikues Disclaimer

1.Accuracy of Information and Right to Modify

The information provided in this document is for reference only. Shikues reserves the right to make changes to this document and to the specifications of the products described herein at any time, without prior notice, for the purpose of improving reliability, function, design, or for any other reason. It is the customer's responsibility to obtain and verify the latest product information and specifications before making any final design, procurement, or usage decisions.

2.No Warranty

Shikues makes no express or implied warranties, representations, or guarantees regarding the suitability of its products for any particular purpose.

Shikues assumes no liability for any assistance provided or for the design of customer products. All products are supplied "as is."

3.Intended Use and Limitation of Liability

The products described in this document are intended for use in general-purpose electronic devices. They are neither designed nor tested nor authorized for use in transportation equipment or applications requiring high reliability. Unless expressly authorized in writing by Shikues, these products must not be used as critical components in life-support systems or any applications where failure could directly pose a risk to human life (including, but not limited to, medical devices, transportation systems, aerospace equipment, nuclear facilities, and safety-critical systems).

Shikues assumes no responsibility or liability for any consequences arising from the use of its products in unauthorized or unintended applications.

Neither Shikues nor its representatives shall be held liable for any resulting damages.

4.Intellectual Property

This document does not grant any express or implied license—whether by estoppel, implication, or otherwise—to use any intellectual property rights of Shikues.