



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.

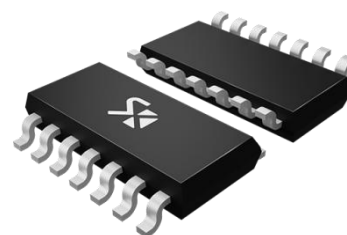
It is widely used in sensor amplifier circuits, DC amplification modules, audio amplifier circuits, and traditional operational amplifier circuits.

Available in SOP14 and DIP14 package types.

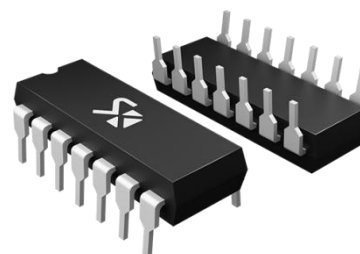
Features

- 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: $\pm 1.5\text{V} \sim \pm 16\text{V}$
- Unity-gain bandwidth: 1.2MHz

Package Outline Drawing



SOP-14

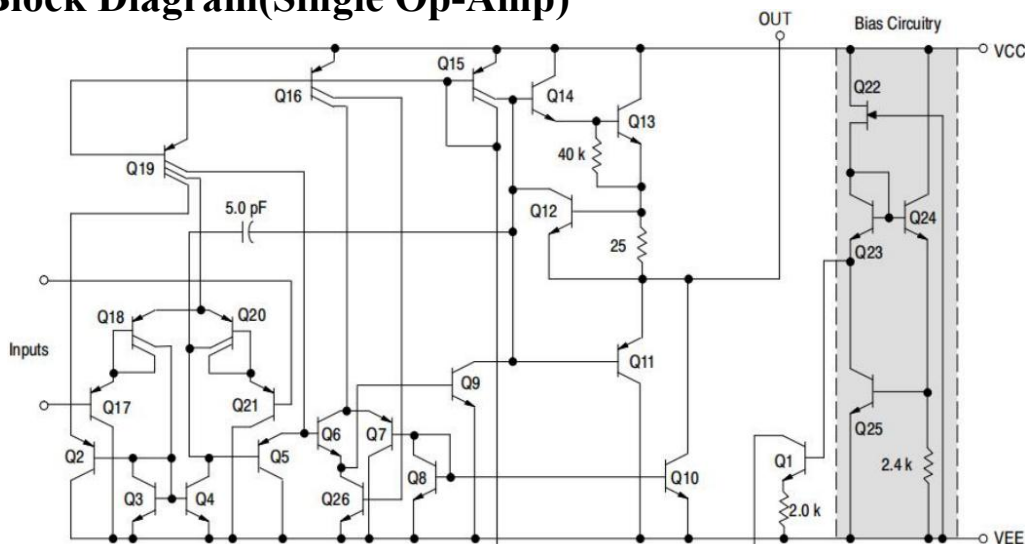


DIP-14

Application

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

Function Block Diagram(Single Op-Amp)



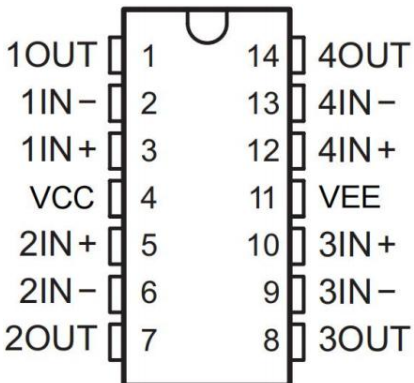


LM324

Ordering Information

Type	Marking	Package
LM324-D14	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 ($T_A=25^{\circ}\text{C}$ 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	$-0.3 \sim V_{CC}$	V
Maximum Operating Junction Temperature	T_J	150	$^{\circ}\text{C}$
Operating Ambient Temperature	T_A	$-20 \sim +85$	$^{\circ}\text{C}$
Storage Temperature	T_S	$-65 \sim +150$	$^{\circ}\text{C}$
Lead Temperature(Soldering, 10s)	T_W	260	$^{\circ}\text{C}$



LM324

Electrical Characteristics($T_A=25^{\circ}\text{C}$, $V_{CC}=5\text{ V}$, $V_{EE}=\text{GND}$ unless otherwise noted)

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



Typical Applications

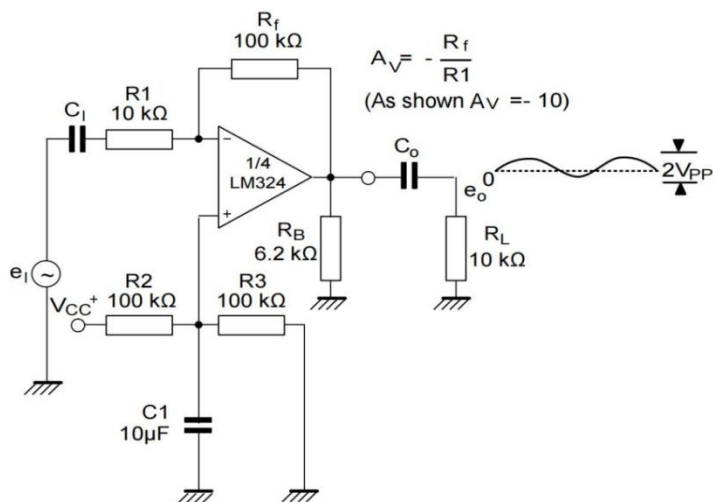


Figure 1.AC-Coupled Inverting Amplifier

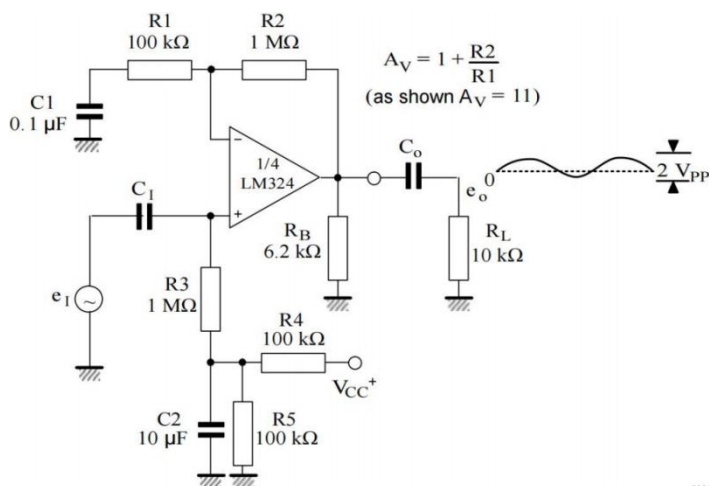


Figure 2.AC-Coupled Non-Inverting Amplifier

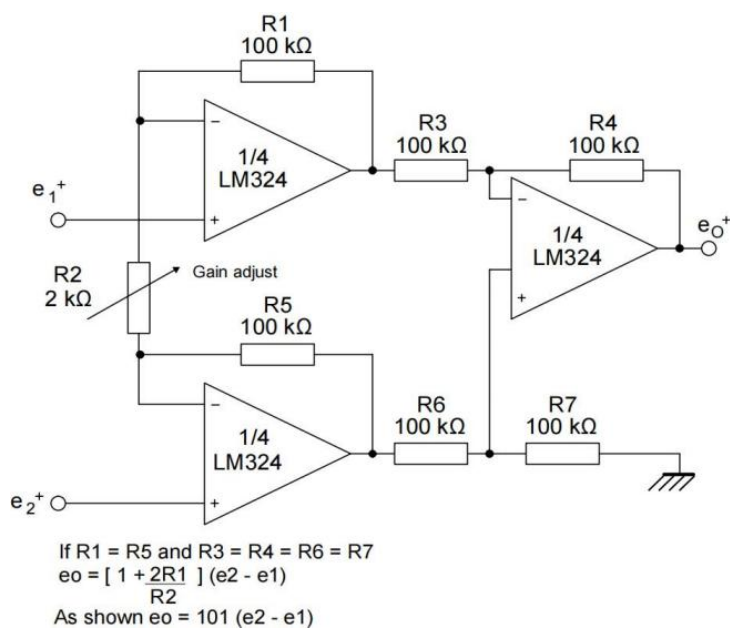


Figure 3.Adjustable Gain DC Instrumentation Amplifier(High Input Impedance)

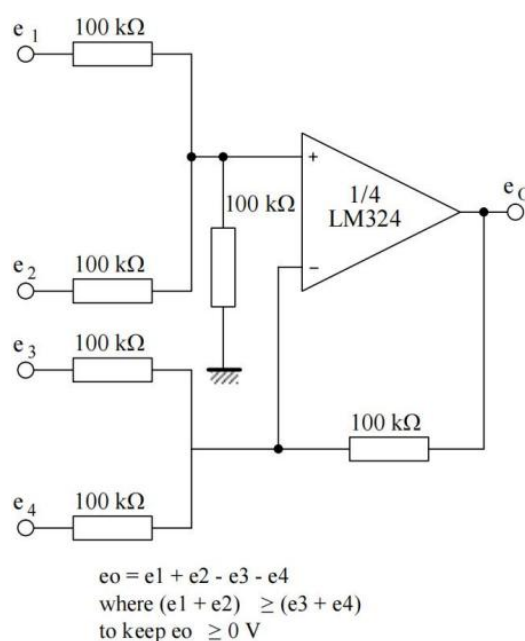


Figure 4. DC Summing Amplifier



Typical Characteristics Curves

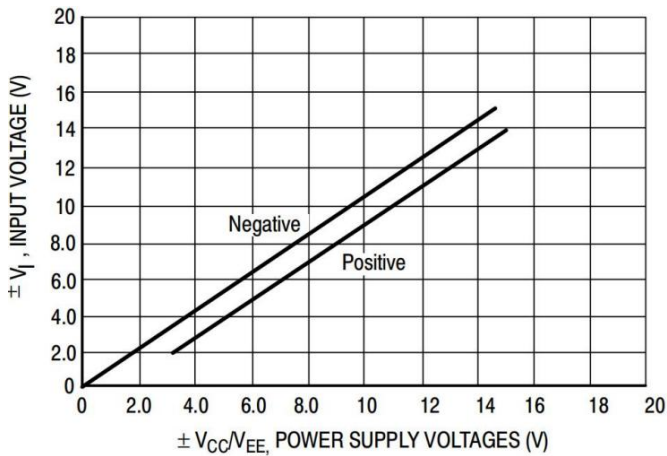


Figure 5. Relationship between Input Voltage and Power Supply Voltage

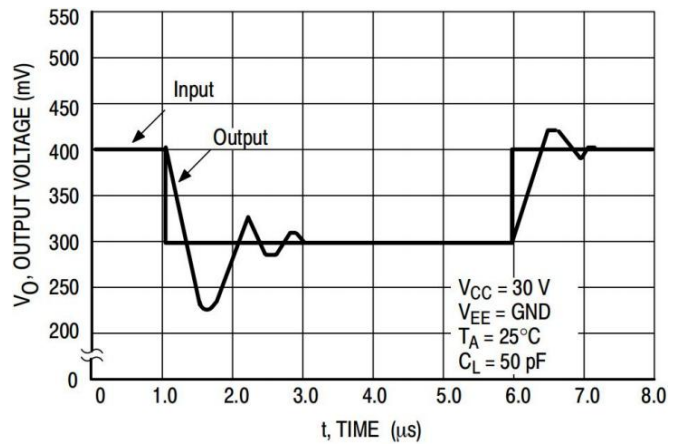


Figure 6. Small-Signal Voltage Follower Pulse Response (No-Inverting)

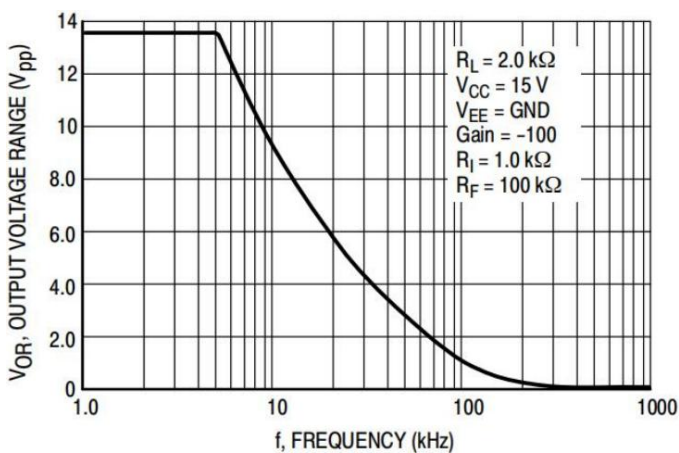


Figure 7. Large-Signal Frequency Response

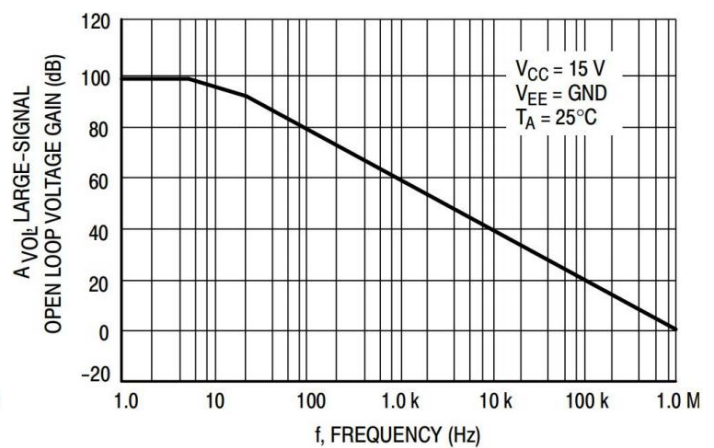


Figure 8. Relationship between Open-Loop Gain and Frequency

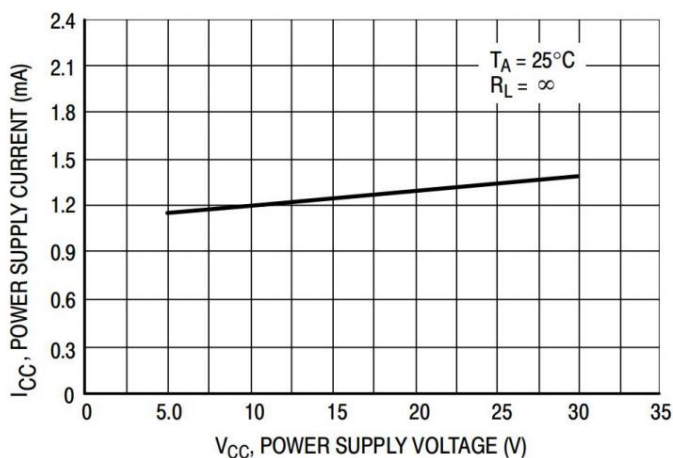


Figure 9. Relationship between Power Supply Current and Power Supply Voltage

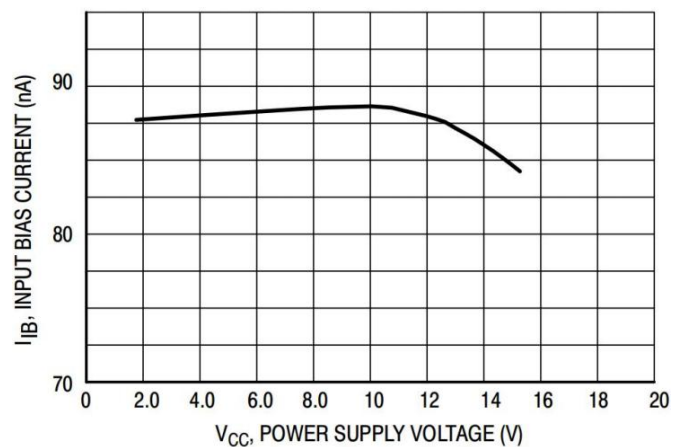
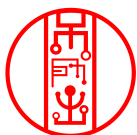


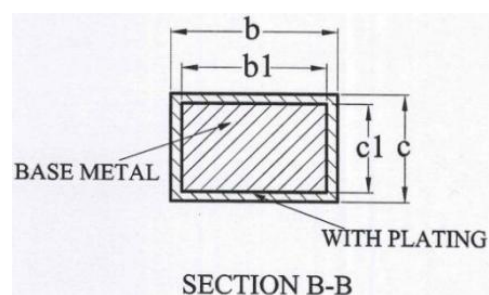
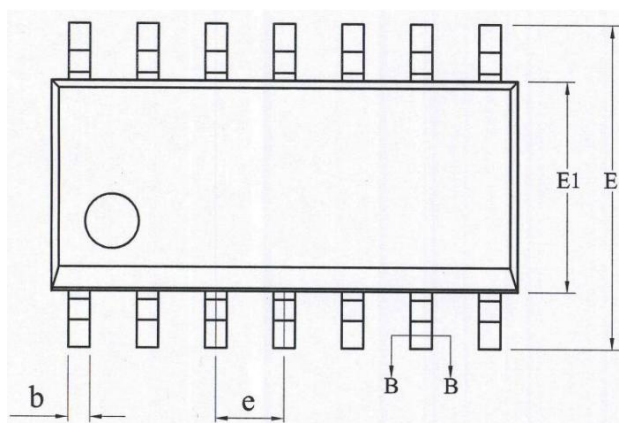
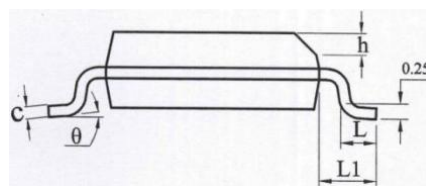
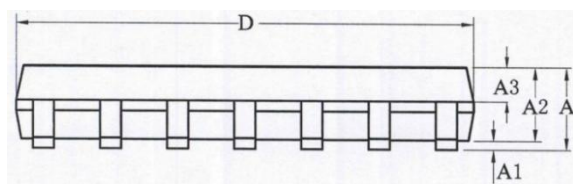
Figure 9. Relationship between Input Bias Current and Power Supply Voltage



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°

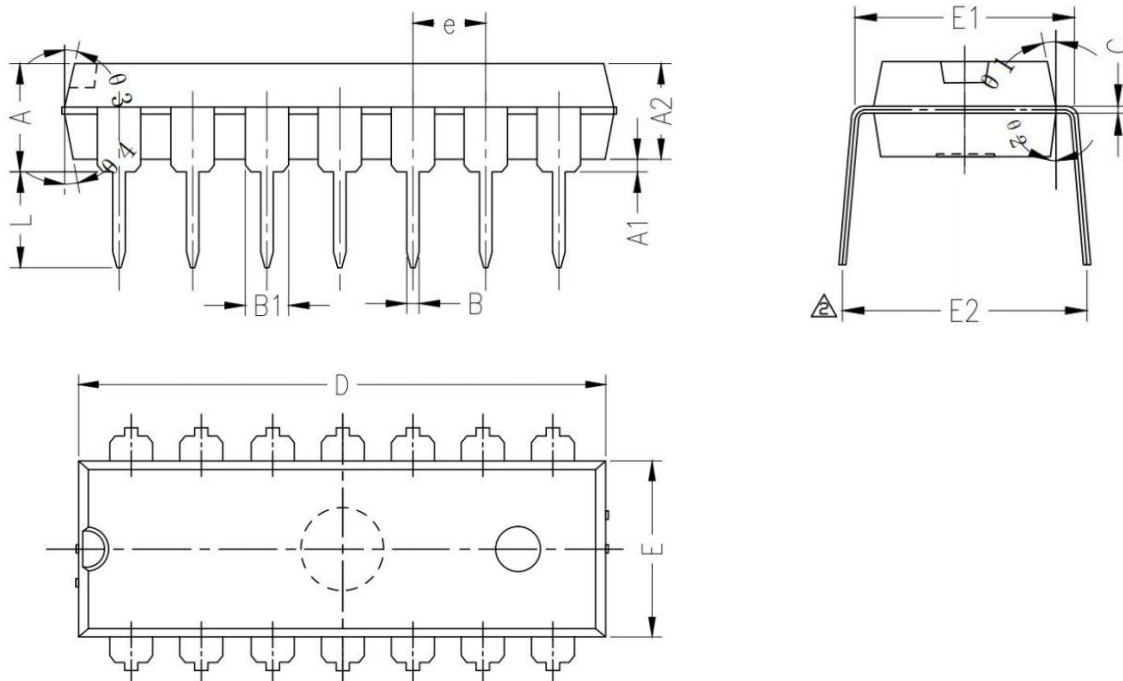


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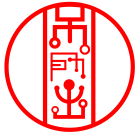
Package Information

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°



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