

Low Power Quad Operational Amplifier

DESCRIPTION

The LM324 contains four independent high gain operational amplifiers with internal frequency compensation. The four op-amps operate over a wide voltage range from a single power supply. Also use a split power supply. The device has low power supply current drain, regardless of the power supply voltage. The low power drain also makes the LM324 a good choice for battery operation.

FEATURES

- Internally frequency-compensated for unity gain
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1 MHz (temperature-compensated)
- Wide power supply range:
 - Single supply: 3VDC to 32 VDC
 - Dual supplies: ± 1.5 VDC to ± 16 VDC
- Differential input voltage range equal to the power supply voltage
- Power drain suitable for battery operation
- Large output voltage swing: 0VDC to $V_{CC}-1.5$ VDC

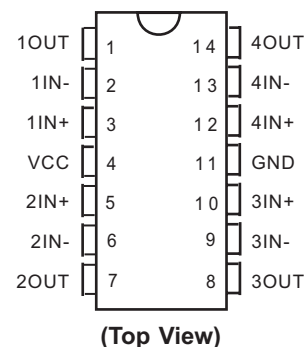
APPLICATIONS

- Transducer Amplifiers
- DC Gain-blocks
- All The Conventional Op Amp Circuits

ORDERING INFORMATION

Temperature Range	Package		Orderable Device	Package Qty
-40°C to +85°C	SOP14	Pb-Free	LM324D	50Units/Tube
			LM324DR	3000Units/R&T
	DIP14		LM324N	25Units/Tube

PIN CONFIGURATION



SCHEMATIC DIAGRAM

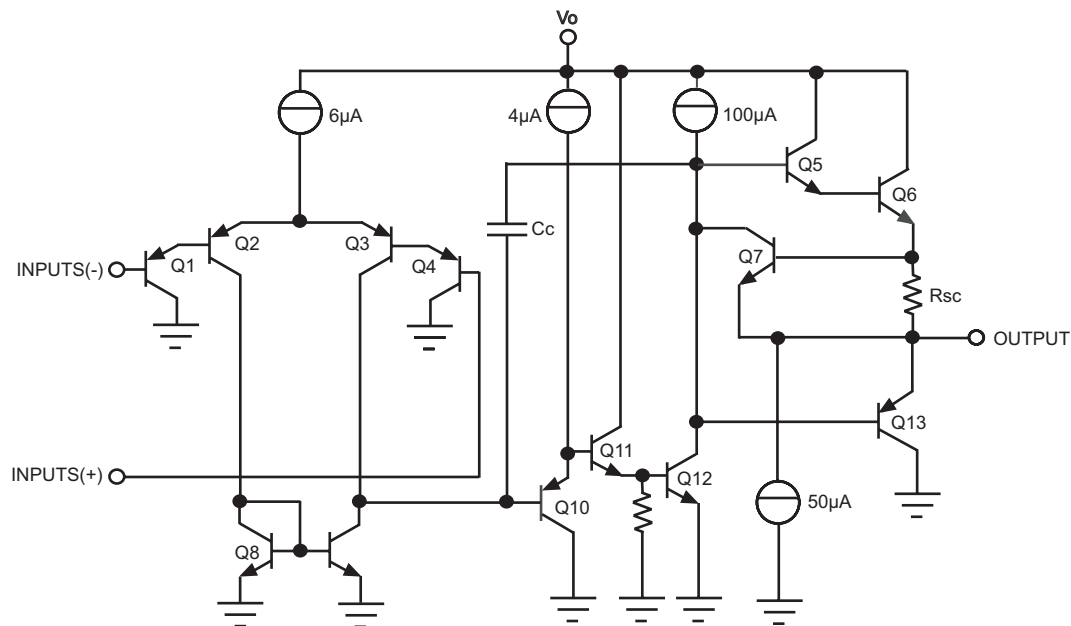


Figure 1. Simplified Block Diagram

ABSOLUTE MAXIMUM RATINGS(NOTE1)

Parameter		Symbol	Value	Unit
Power Supply Voltages	Single Supply	V _{CC}	32	V
	Split Supplies		± 16	
Input Differential Voltage Range(Note 2)		V _{IDR}	±32	V
Input Common Mode Voltage Range		V _{ICR}	-0.3 to 32	V
Output Short Circuit Duration		I _{SC}	Continuous	
Junction Temperature (Plastic Packages)		T _J	150	°C
Storage Temperature (Plastic Packages)		T _{Stg}	-55 to +125	°C
Input Current,per pin(Note 3)		I _{IN}	50	mA
Lead Temperature,1mm from Case for 10 Seconds		T _L	260	°C

Note 1: Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.
Power Derating:

DIP Package:-10mW/°C from 65 to 125°C

SOP Package:-7mW/°C from 65 to 125°C

Note 2: Split Power Supplies.

Note 3: $V_{IN} < -0.3V$. This input current will only exist when voltage at any of the input leads is driven negative.

RECOMMENDED OPERATING CONDITIONS

Parameter		Symbol	Min	Max	Unit
DC Supply Voltage	Single Supply	V_{CC}	5.0	30	V
	Split Supplies		± 2.5	+15	
Operating Temperature, All Package Types		T_A	-40	+85	$^{\circ}\text{C}$

Notes: This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{IN} and V_{OUT} should be constrained to the range $\text{GND} \leq (V_{IN} \text{ or } V_{OUT}) \leq V_{CC}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V_{CC}).

Unused outputs must be left open.

DC ELECTRICAL CHARACTERISTICS($T_A = -40$ to $+85^{\circ}\text{C}$)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Maximum Input Offset Voltage	V_{IO}	$V_O = 1.4\text{V}, V_{CC} = 5.0\text{--}30\text{V}$ $R_S = 0, V_{ICM} = 0\text{V to } V_{CC} - 1.7\text{V}$			9.0 5.0*	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$R_S = 0\Omega, V_{CC} = 30\text{V}$		7.0		$\mu\text{V}/^{\circ}\text{C}$
Maximum Input Offset Current	I_{IO}	$V_{CC} = 5.0\text{V}$			150 50*	nA
Input Offset Current Drift	$\Delta I_{IO}/\Delta T$	$R_S = 0\Omega, V_{CC} = 30\text{V}$		10		$\text{pA}/^{\circ}\text{C}$
Maximum Input Bias Current	I_{IB}	$V_{CC} = 5.0\text{V}$			500 250*	nA
Input Common Mode Voltage Range	V_{ICR}	$V_{CC} = 30\text{V}$	0		28	V
Maximum Power Supply Current	I_{CC}	$R_L = \infty, V_{CC} = 30\text{V}, V_O = 0\text{V}$			3	mA
		$R_L = \infty, V_{CC} = 5\text{V}, V_O = 0\text{V}$			1.2	
Minimum Large Signal Open-Loop Voltage Gain	A_{VOL}	$V_{CC} = 15\text{V}$ $R_L \geq 2\text{k}\Omega$	15 25*			V/mV
Minimum Output Low-Level Voltage Swing	V_{OH}	$V_{CC} = 30\text{V}, R_L = 2\text{k}\Omega$	26			V
		$V_{CC} = 30\text{V}, R_L = 10\text{k}\Omega$	27			
Maximum Output Low-Level Voltage Swing	V_{OL}	$V_{CC} = 5\text{V}, R_L = 10\text{k}\Omega$			20	mV
Common Mode Rejection	CMR	$V_{CC} = 30\text{V}, R_L = 10\text{k}\Omega$	65*			dB

DC ELECTRICAL CHARACTERISTICS(CONTINUED)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Power Supply Rejection	PSR	$V_{CC}=30V$	65*			dB
Channel Separation	CS	$f=1kHz$ to $20kHz$, $V_{CC}=30V$	-120*			dB
Maximum Output Short Circuit to GND	I_{SC}	$V_{CC}=5.0V$			60*	mA
Minimum Output Source Current	I_{SOURCE}	$V_{IN+}=1V, V_{IN-}=0V$, $V_{CC}=15V, V_O=0V$	-10			mA
Minimum Output Sink Current	I_{SINK}	$V_{IN+}=0V, V_{IN-}=1V$, $V_{CC}=15V, V_O=15V$	5 10*			mA
		$V_{IN+}=0V, V_{IN-}=1V$, $V_{CC}=15V, V_O=0.2V$	12*			μA
Differential Input Voltage Range	V_{IOR}	ALL $V_{IN}>GND$ or V-Supply(if used)			V_{CC}^*	V

*at $T_A=25^{\circ}C$

TYPICAL PERFORMANCE CHARACTERISTICS

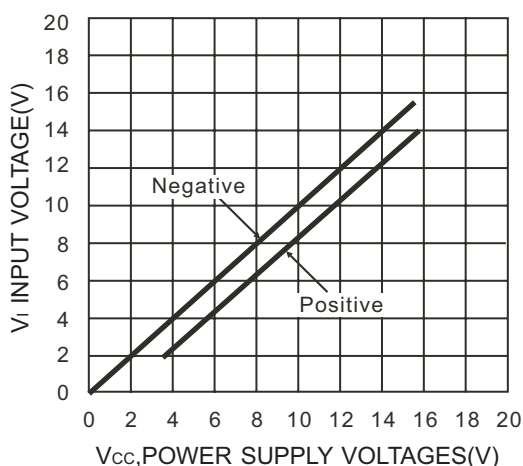


Figure 2. Input Voltage Range

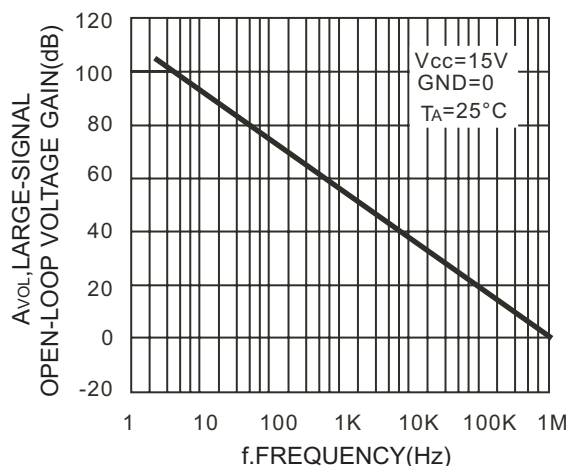


Figure 3. Open-Loop Frequency

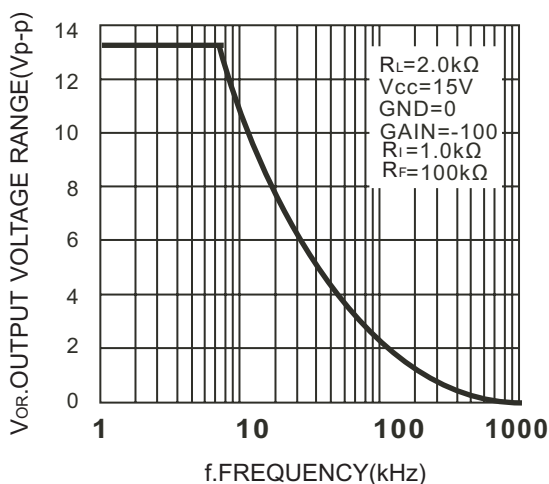


Figure 4. Large-signal Frequency Response

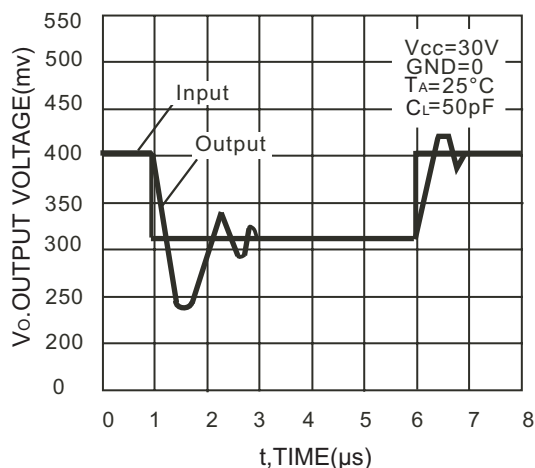


Figure 5. Small-Signal Voltage Follower Pulse Response(Non inverting)

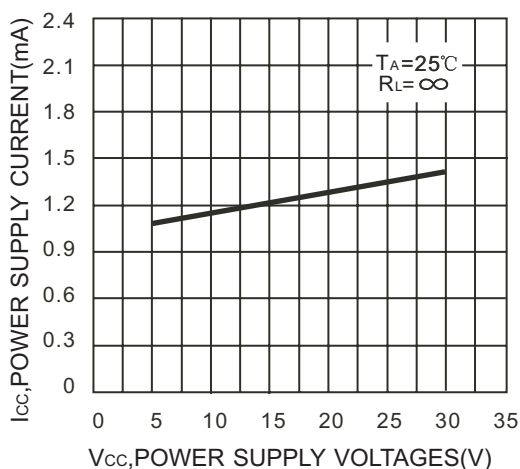


Figure 6. Power Supply Current Versus Power Supply Voltage

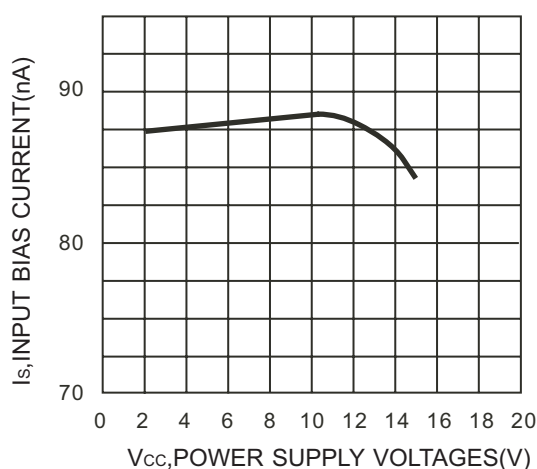


Figure 7. Input Bias Current Versus Power Supply Voltage

TYPICAL APPLICATION

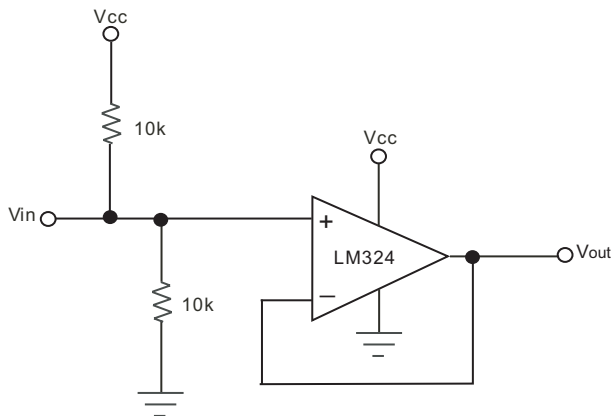


Figure 8. Input Biasing Voltage-Follower

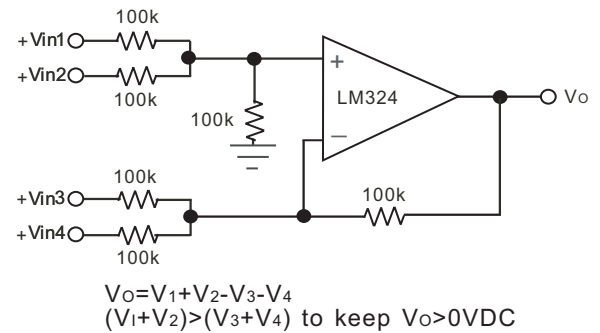


Figure 9. DC Summing Amplifier

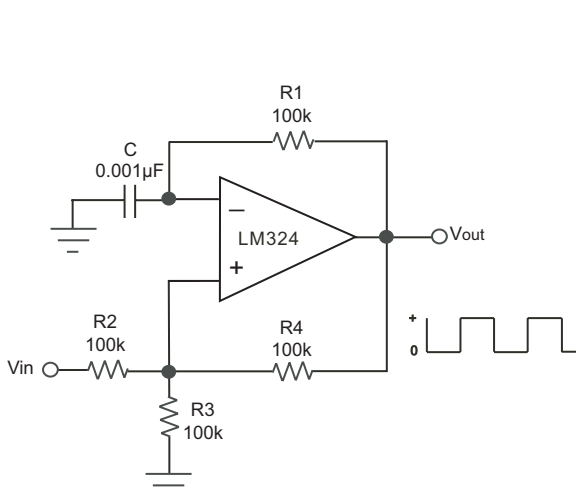


Figure 10. Square Wave Oscillator

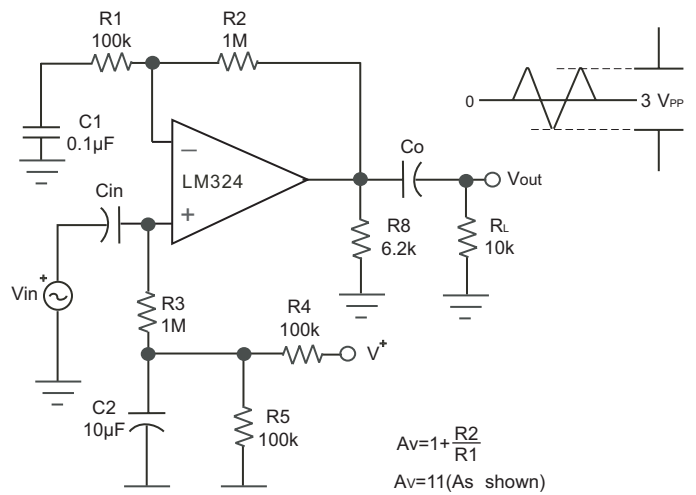


Figure 11. AC Coupled Non-inverting Amplifier

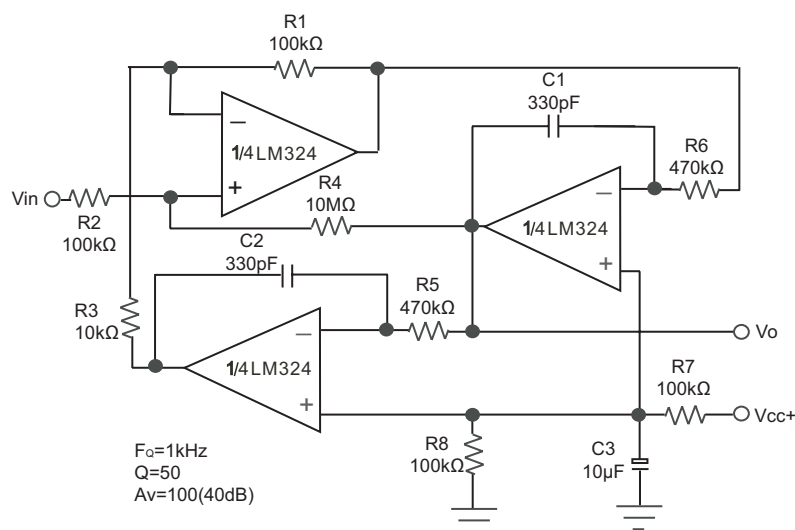
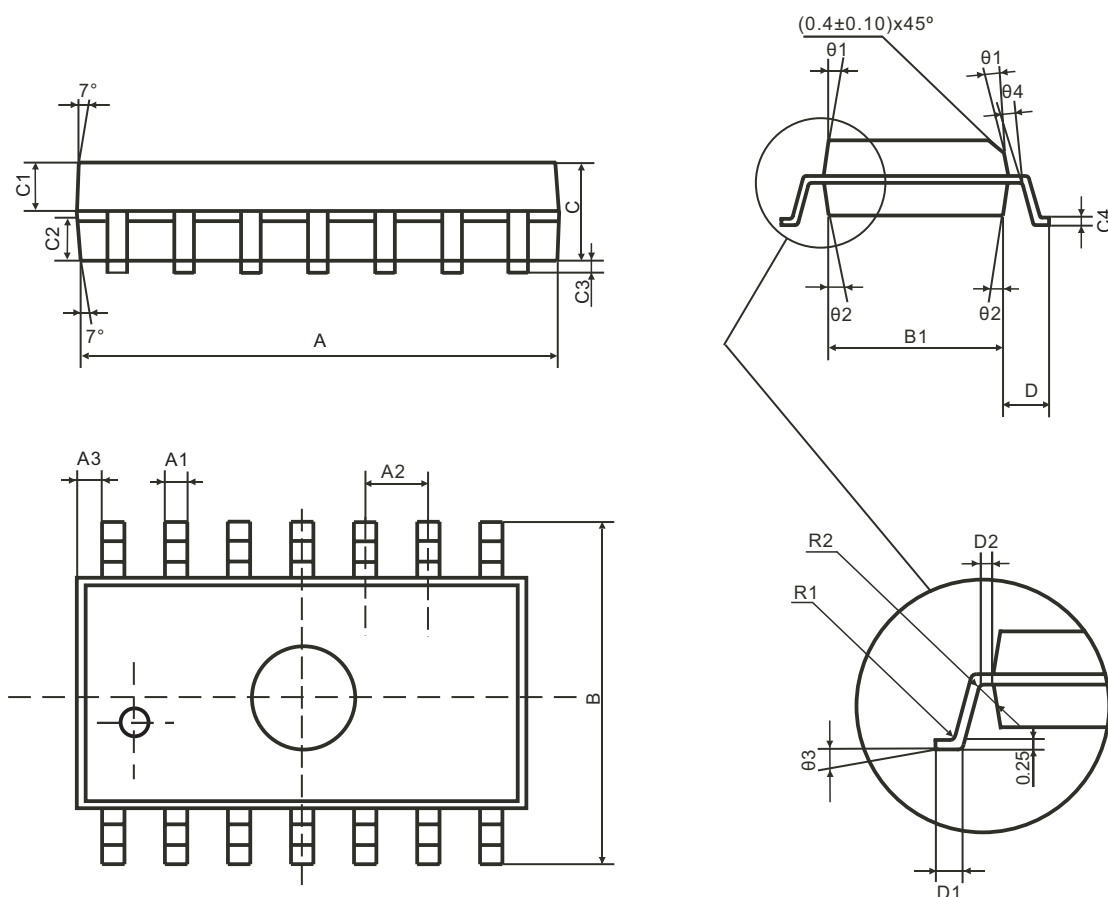


Figure 12. Active Bandpass Filter

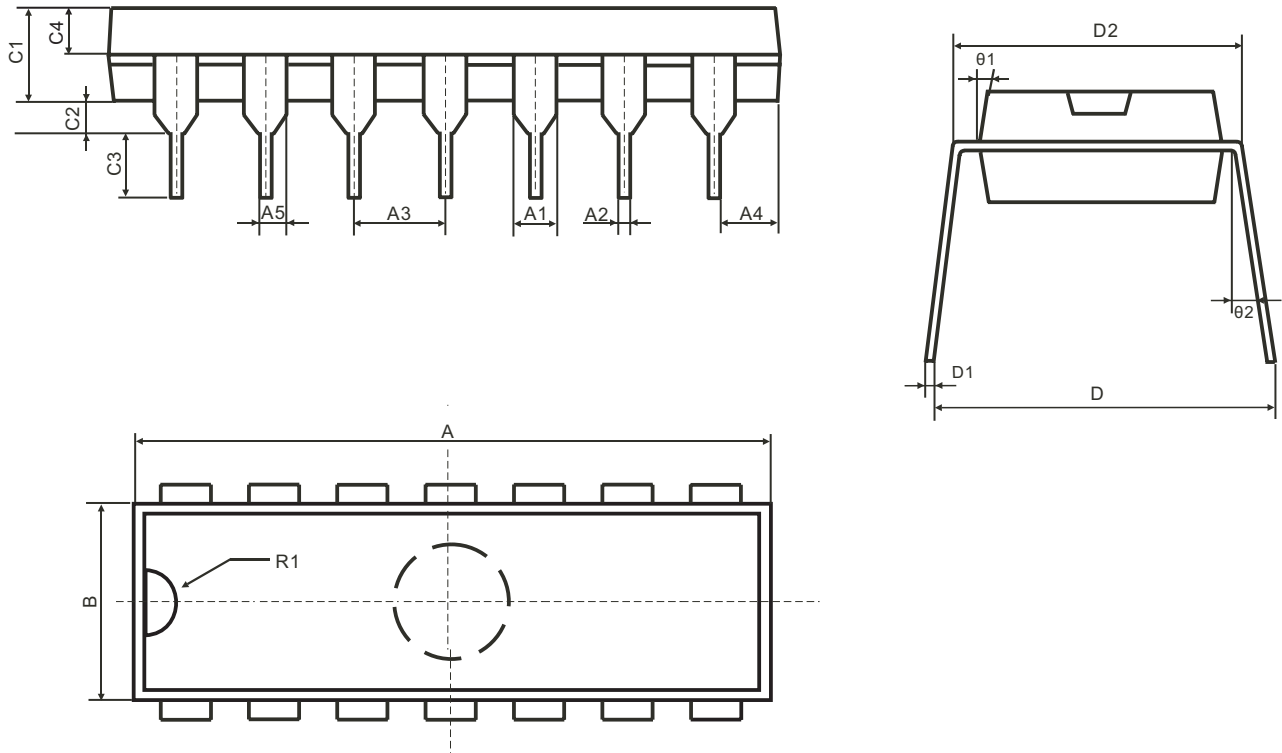
PHYSICAL DIMENSIONS

SOP14L



Symbol	Dimension(mm)		Symbol	Dimension(mm)	
	Min	Max		Min	Max
A	8.55	8.75	C4	0.17	0.25
A1	0.330	0.510	D	1.05(TYP)	
A2	1.27(TYP)		D1	0.45	0.65
A3	0.305(TYP)		D2	0.25(TYP)	
B	5.8	6.2	R1	0.2(TYP)	
B1	3.8	4	R2	0.2(TYP)	
C	1.35	1.55	θ1	8°(TYP)	
C1	0.60	0.70	θ2	8°(TYP)	
C2	0.55	0.65	θ3	4°(TYP)	
C3	0.10	0.25	θ4	4°(TYP)	

DIP14L



Symbol	Dimension(mm)		Symbol	Dimension(mm)	
	Min	Max		Min	Max
A	19.00	19.20	C3	3.15	3.45
A1	1.524(TYP)		C4	1.57	1.67
A2	0.39	0.53	D	8.20	8.80
A3	2.54(TYP)		D1	0.20	0.35
A4	1.7(TYP)		D2	7.62	7.87
A5	0.99(TYP)		θ1	8°(TYP)	
B	6.3	6.5	θ2	5°(TYP)	
C1	3.40	3.60	R1	1.0(TYP)	
C2	0.51(TYP)				