

Low-Power Dual Operational Amplifiers

Features

- Bandwidth: 1.0MHz
- Large DC Voltage Gain: 100 dB
- Input Voltage Range: -0.3V to +36V or $\pm 1.5V$ to $\pm 18V$
- Low input bias current: 500 μ A
- Differential input voltage range equal to the power supply voltage
- Operating temperature range: -40°C to +125°C
- Input common-mode voltage range includes negative rails
- Input Offset Voltage: 2.0mV(Typ.)
- Large output voltage swing 0 V to ($V_{CC}^+ - 1.5 V$)

Applications

- Power Module
- Sensor Interface
- Motor Control
- Audio
- Battery Charger
- Cordless Telephone

General Description

These circuits consist of two independent, high-gain, internally frequency-compensated op amps, specifically designed to operate from a single power supply or dual power supplies over a wide range of voltages. The low-power supply drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits.

In linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

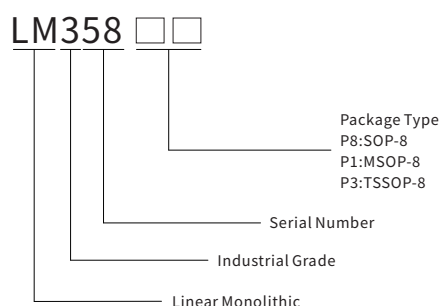
Reference News

SOP-8 Marking:
LM358P8: R+O+LM358+Date code

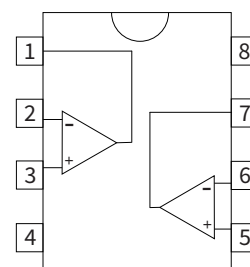
MSOP-8 Marking:
LM358P1: R+O+LM358+Date code

TSSOP-8 Marking:
LM358P3: R+O+LM358+Date code

Part Numbering



Pin Configuration



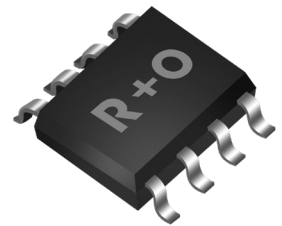
Supply Voltage

+3.0V ~ +36V

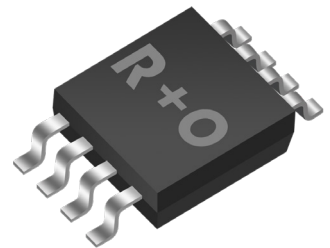
Offset Voltage

2.0mV

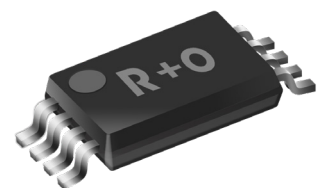
SOP-8



MSOP-8



TSSOP-8



● Pin Description

Pin Number	Pin Name	Description
	SOP-8/MSOP-8/TSSOP-8	
1	OUT1	Output, channel 1
2	IN-	Inverting input, channel 1
3	IN+	Noninverting input, channel 1
4	V-	V_{CC-}
5	IN2+	Inverting input, channel 2
6	IN2-	Noninverting input, channel 2
7	OUT2	Output, channel 2
8	V+	V_{CC+}

● Ordering Information

Order Number	Package	Package Code	Unit Weight(g)	Tube/Reel(pcs)	Box(pcs)	Carton(pcs)	Delivery Mode
LM358P8	SOP-8	R3	0.077	100/4000	8000	80000	13"
LM358P1	MSOP-8	R3	0.0248	100/4000	8000	64000	13"
LM358P3	TSSOP-8	R3	0.365	100/4000	8000	64000	13"

● Functional Block Diagram

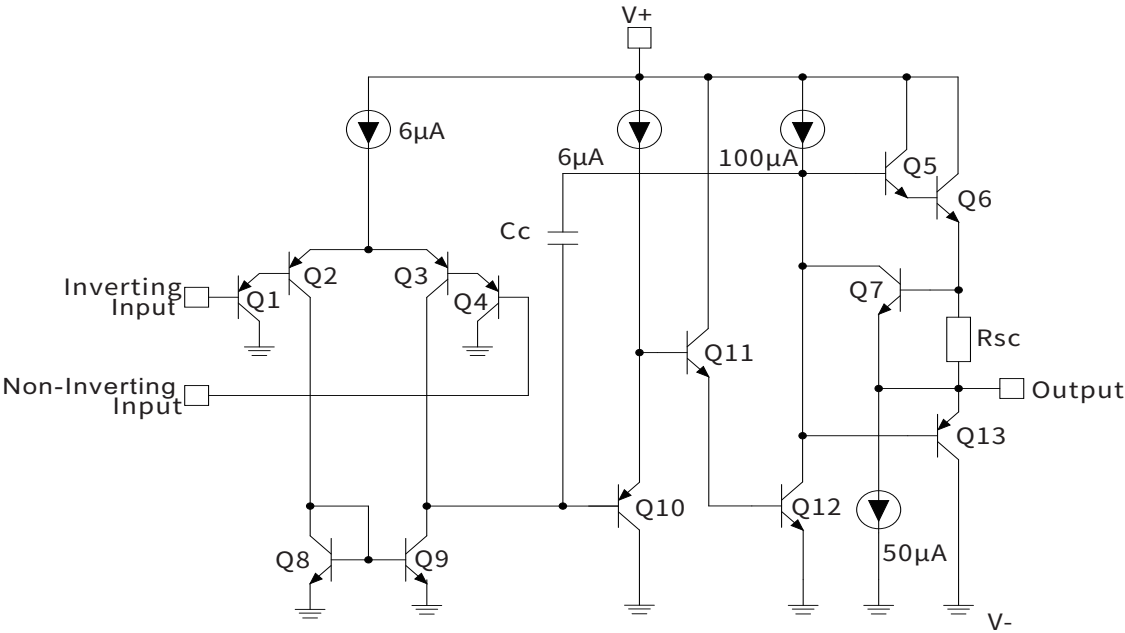


Figure 1.Internal Block Diagram

● **Absolute Maximum Ratings** ($T_A=25^{\circ}\text{C}$ Unless otherwise specified.)

Parameter	Symbol	Value		Unit
Supply Voltage, $(+V_S)-(-V_S)$	V_{CC}	36V or $\pm 18\text{V}$		V
Differential input voltage	V_{id}	36		V
Input voltage	V_i	-0.3 to 36		V
Maximum Junction Temperature	T_J	150		$^{\circ}\text{C}$
Common Mode Input Voltage Range($T_A = 25^{\circ}\text{C}$)	V_{ICR}	0 to $(V_{CC+}) - 1.5$		V
Output short-circuit to GND ^{Note1}	I_{SC}	Infinite		mA
Input current($V_{IN} < -0.3\text{V}$) ^{Note2}	I_i	50		mA
Thermal resistance junction to ambient ^{Note3}	R_{thja}	SOP8	125	$^{\circ}\text{C} / \text{W}$
		MSOP8	190	
		TSSOP8	120	
Thermal resistance junction to case ^{Note3}	R_{thjc}	SOP8	40	
		MSOP8	56	
		TSSOP8	37	
Operating Temperature Range	T_{OPR}	-40 to 125°C		$^{\circ}\text{C}$
Storage Temperature Range	T_{STG}	-65 to 150°C		$^{\circ}\text{C}$

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime. Electrostatic discharge can also cause damage to chips, so it is suggested to take some preventive measures for integrated circuits. Failure to follow proper handling and installation can also cause damage. Precision LM358 and other devices are more vulnerable to damage than ordinary devices in the case of tiny electrostatic, and small parameter changes may make the whole circuit performance substandard.

Note1. Short-circuits from the output to V_{CC} can cause excessive heating if $V_{CC} > 15\text{V}$. The maximum output current is approximately 40mA independent of the magnitude of V_{CC} . Destructive dissipation can result from simultaneous short circuits on all amplifiers.

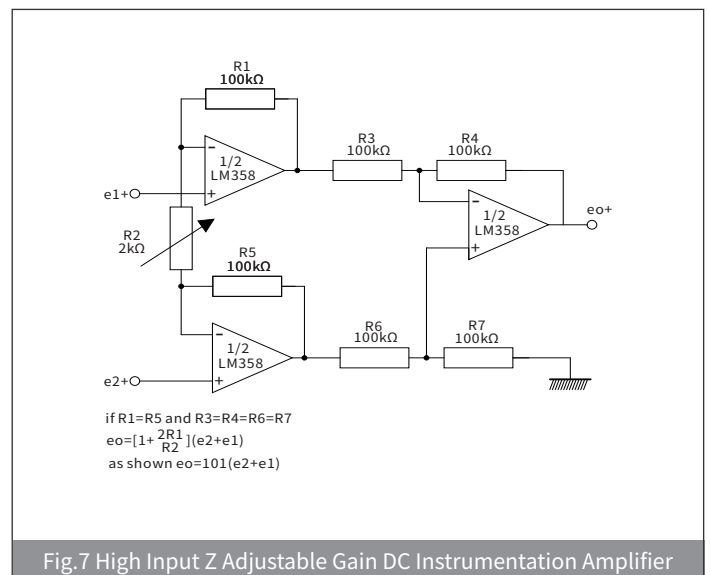
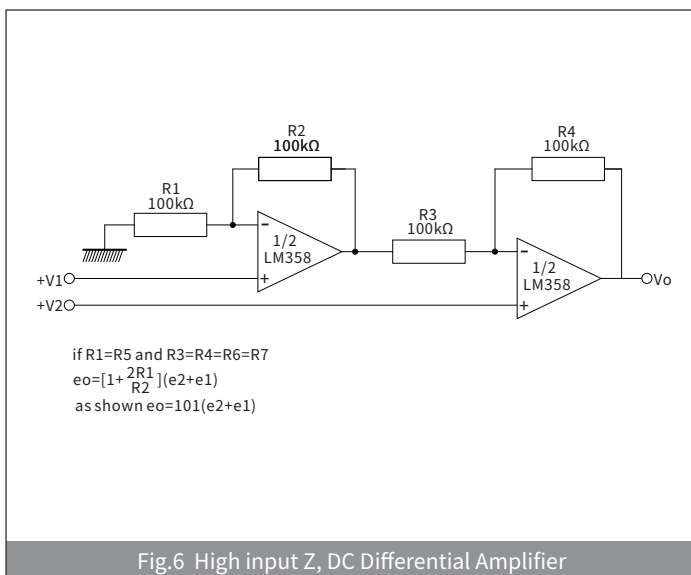
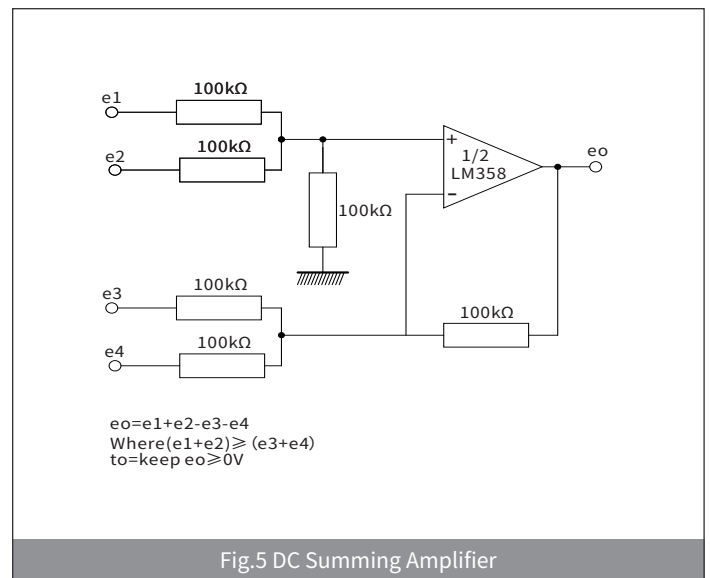
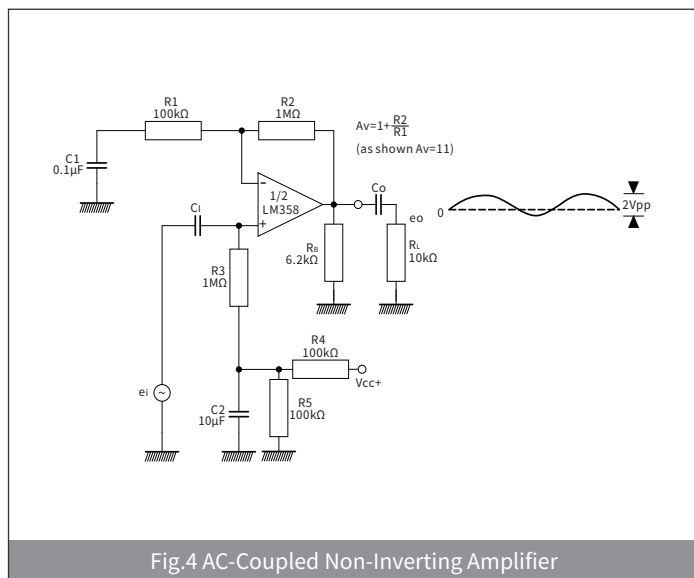
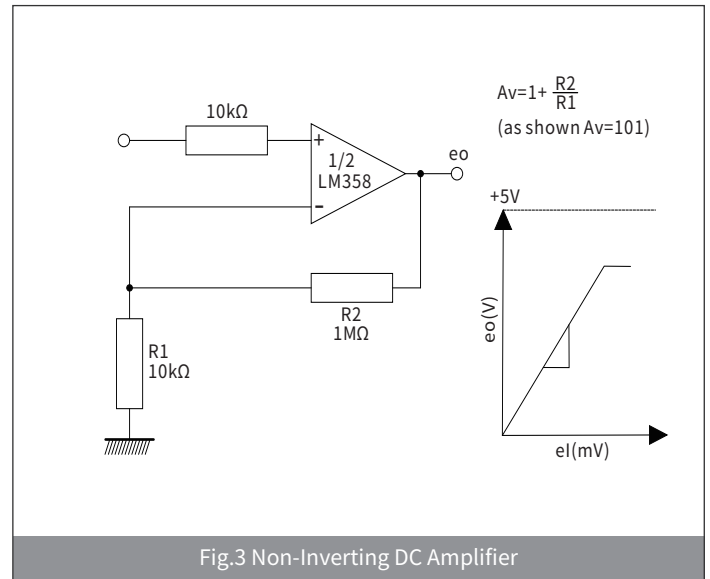
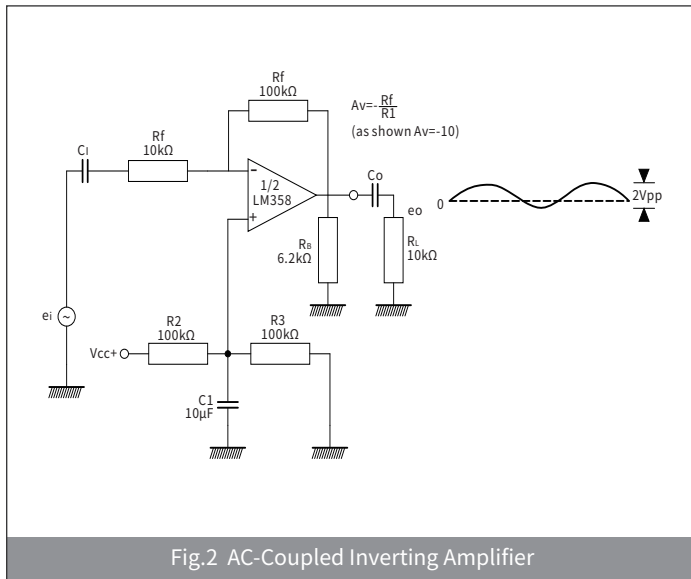
Note2. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward-biased and thereby acting as input diode clamp. In addition to this diode action, there is NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time during which an input is driven negative. This is not destructive and normal output is restored for input voltages above -0.3V.

Note3. Short-circuits can cause excessive heating and destructive dissipation. R_{th} are typical values.

● **Electrical Characteristics** ($V_{CC+} = 5V$, $V_{CC-} = \text{Ground}$, $T_A = 25^\circ\text{C}$, unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
AC Specifications						
Gain-Bandwidth Product	GBW	$C_L = 100\text{pF}$	--	1.0	--	MHz
Slew Rate	SR	$A_V = 20\text{dB}$, $V_{OUT} = 2V_{P-P}$, $C_{LOAD} = 100\text{pF}$ $R_{LOAD} = 2\text{k}\Omega$, $f = 1\text{kHz}$	--	0.4	--	V/ μs
DC Characteristics						
Input Offset Voltage	V_{OS}	$T_A = 25^\circ\text{C}$	--	1	3	mV
		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	--	--	7	mV
Input Bias Current	I_B	$T_A = 25^\circ\text{C}$	--	25	250	nA
		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	--	50	500	nA
Input Offset Current	I_{OS}	$T_A = 25^\circ\text{C}$	--	5	50	nA
		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	--	--	150	nA
Power Supply Rejection Ratio	PSRR	$V_{CC+} = 5.0V$ to $30V$	75	100	--	dB
Large Signal Voltage Gain	A_{vd}	$V_{CC+} = 15V$, $R_L \geq 2\text{k}\Omega$, $V_o = 1V$ to $11V$	50	100	--	dB
		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	25	--	--	dB
Quiescent Current	I_Q	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$, $V_{CC+} = 30V$, $R_L = \infty$	--	1.0	3.0	mA
		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$, $V_{CC+} = 5.0V$, $R_L = \infty$	--	0.5	1.2	mA
Short-Circuit Current	I_{SC}	$V_{CC+} = 15V$	--	40	60	mA
V_{o1}/V_{o2}	Channel separation	$1\text{kHz} \leq f \leq 20\text{kHz}$	--	-120	--	dB
Input Characteristics						
Common-mode Input Voltage Range	V_{CMR}	$V_{CC+} = 30V$, $T_A = 25^\circ\text{C}$	0	--	$V_{CC+} - 1.5$	V
		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	0	--	$V_{CC+} - 2$	V
Common Mode Rejection Ratio	CMRR	$V_{CM} = 0$ to $V_{CC+} - 1.5V$	70	90	--	dB
Output Characteristics						
Output Current	I_{source}	$V_{IN}(+) = 1V$, $V_{IN}(-) = 0V$, $V_{CC+} = 15V$, $V_o = 2V$	20	40	--	mA
	I_{sink}	$V_{IN}(-) = 1V$, $V_{IN}(+) = 0V$, $V_{CC+} = 15V$, $V_o = 2V$	10	20	--	mA
		$V_{IN}(-) = 1V$, $V_{IN}(+) = 0V$, $V_{CC+} = 15V$, $V_o = 200\text{mV}$	12	50	--	μA
Output Voltage Swing	V_{OH}	$V_{CC+} = 30V$, $R_L = 2\text{k}\Omega$	26	--	--	V
		$V_{CC+} = 30V$, $R_L = 10\text{k}\Omega$	27	28	--	V
	V_{OL}	$V_{CC+} = 5V$, $R_L = 100\text{k}\Omega$	--	5	20	mV

● Typical Applications(Single Supply Voltage $V_{CC+} = 5.0V$, $V_{CC-} = 0V$)



● Typical Applications(Cont.)

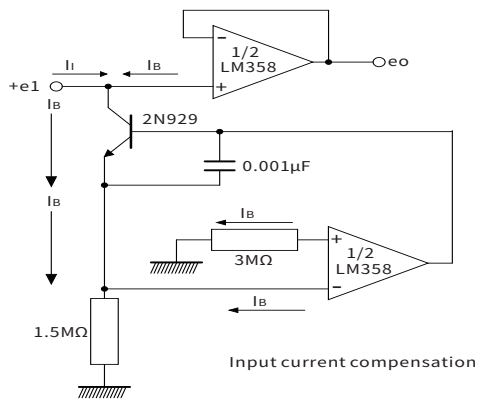


Fig.8 Using Symmetrical Amplifiers to Reduce Input Current

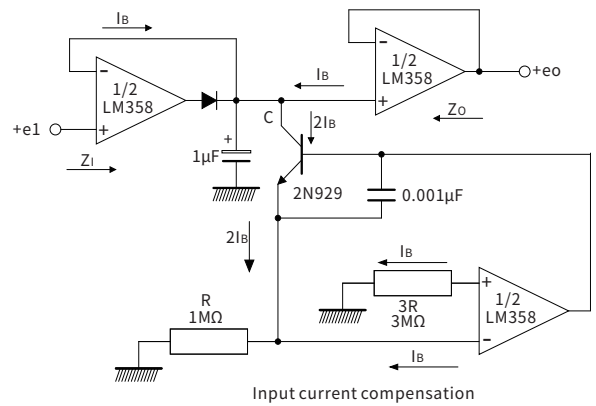


Fig.9 Low Drift Peak Detector

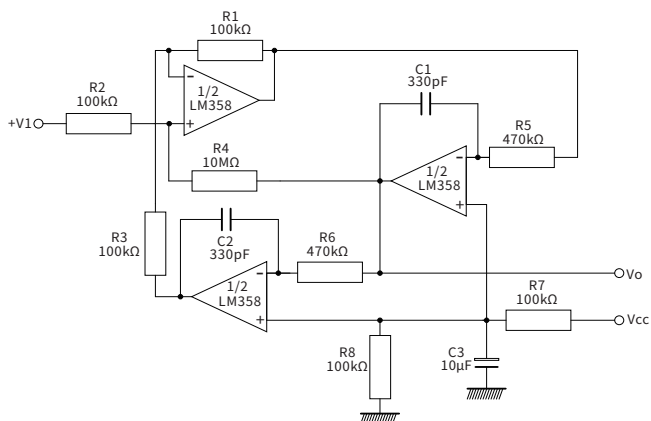
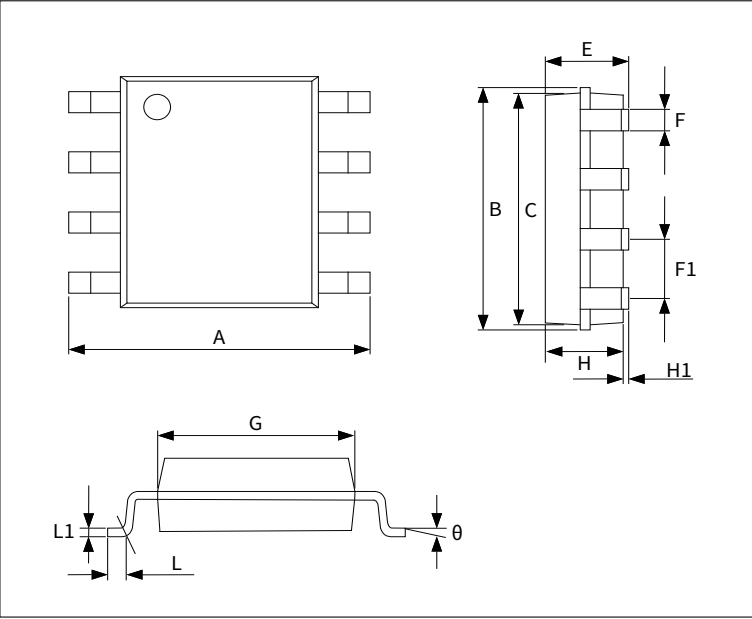


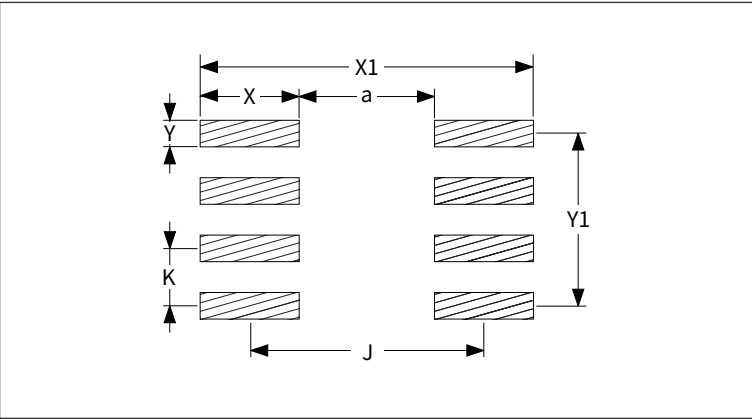
Fig.10 Active Band-Pass Filter

● Package Outline Dimensions (SOP-8)



Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	5.70	6.30	0.224	0.248
B	5.13MAX.		0.202MAX.	
C	4.72	5.12	0.186	0.201
E	1.80MAX.		0.071MAX.	
F	0.31	0.51	0.0122	0.020
F1	1.27TYP.		0.050TYP.	
G	3.75	4.15	0.148	0.163
H	1.35	1.65	0.053	0.065
H1	0.1	0.25	0.004	0.010
L	0.3	0.7	0.012	0.028
L1	0.21TYP.		0.008TYP.	
θ	-	8°	-	8°

● Suggested Pad Layout



Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
a	2.90	3.10	0.114	0.122
J	5.10	5.30	0.201	0.209
K	1.17	1.37	0.046	0.054
X	2.10	2.30	0.083	0.091
X1	7.30	7.50	0.287	0.295
Y	0.50	0.70	0.020	0.028
Y1	3.71	3.91	0.146	0.154

LM358 Series

Operational Amplifier

Package Outline Dimensions (MSOP-8)

Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.82	1.10	0.032	0.043
A1	0.02	0.15	0.001	0.006
A2	0.75	0.95	0.030	0.037
b	0.25	0.38	0.010	0.015
c	0.09	0.23	0.004	0.009
D	2.90	3.10	0.114	0.122
E	2.90	3.10	0.114	0.122
E1	4.75	5.05	0.187	0.199
e	0.65BSC		0.026BSC	
L	0.40	0.80	0.016	0.031
θ	0.00	6°	0.00	6°

Suggested Pad Layout

Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
X	0.31	0.51	0.012	0.020
Y	0.92	1.12	0.036	0.044
M	0.55	0.75	0.022	0.030
N	4.70	4.90	0.185	0.193

LM358 Series

Operational Amplifier

Package Outline Dimensions (TSSOP-8)

Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	—	1.20	—	0.047
A1	0.05	0.15	0.002	0.006
A2	0.80	1.00	0.031	0.039
A3	0.35	0.41	0.014	0.016
b	0.19	0.30	0.007	0.012
c	0.09	0.20	0.004	0.008
D	2.90	3.10	0.114	0.122
E	6.25	6.55	0.246	0.258
E1	4.30	4.50	0.169	0.177
e	0.65 BSC		0.026 BSC	
L	0.95	1.05	0.037	0.041
L1	0.50	0.70	0.020	0.028
θ	1°	7°	1°	7°

Suggested Pad Layout

Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
J	1.016	—	0.040	—
K	0.305	—	0.012	—
N	6.655	—	0.262	—
M	4.623	—	0.182	—
X	2.337	—	0.092	—
X1	0.356	—	0.014	—
Y	0.660	—	0.026	—