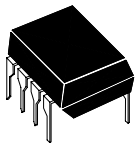
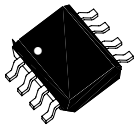
LM358
Low Power Dual Operational Amplifiers



8-Lead Plastic **DIP-8**
Package Code: P



8-Lead Plastic **SO-8**
Package Code: S

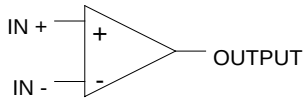
Description

These devices consist of two independent, high gain, internally frequency-compensated operational amplifiers designed operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3V to 32V, and Vcc is at least 1.5V more positive than the input common-mode voltage, The low supply-current drain is independent of the magnitude of the power supply voltage.

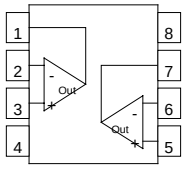
Features

- Two internally compensated OP amps
- Internally frequency compensated for unity gain
- Short Circuit Protected Outputs
- Wide power supply range: $3V_{DC}$ to $32V_{DC}$ (Single supply)
- Input common-mode voltage range includes ground
- Large output voltage swing: $0V_{DC}$ to Vcc-$1.5V_{DC}$

Logic Diagram (each amplifier)

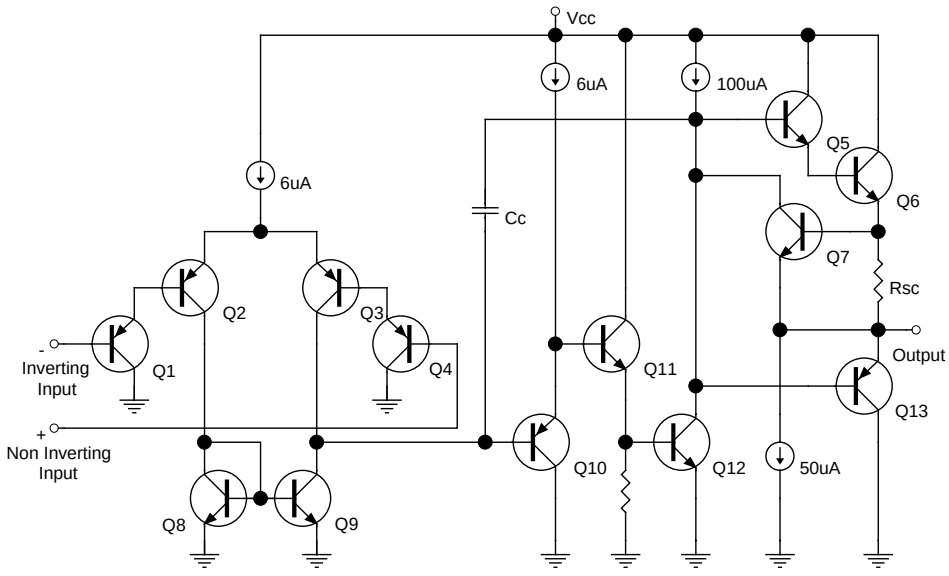


Pin Configurations



Pin 1: Output 1	Pin 5 : Non Inverting Input 2
Pin 2: Inverting Input 1	Pin 6 : Inverting Input 2
Pin 3: Non Inverting Input 1	Pin 7 : Output 2
Pin 4: V_{EE}	Pin 8 : Vcc

Schematic Diagram



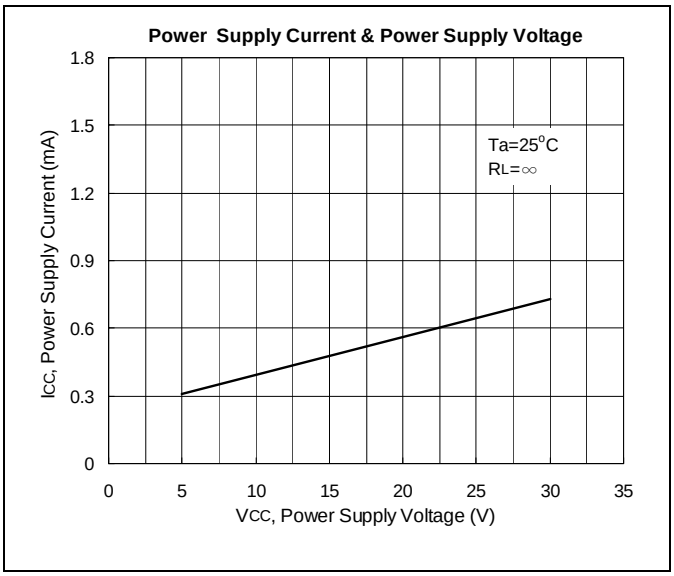
Absolute Maximum Ratings (Ta=25°C, unless otherwise specified)

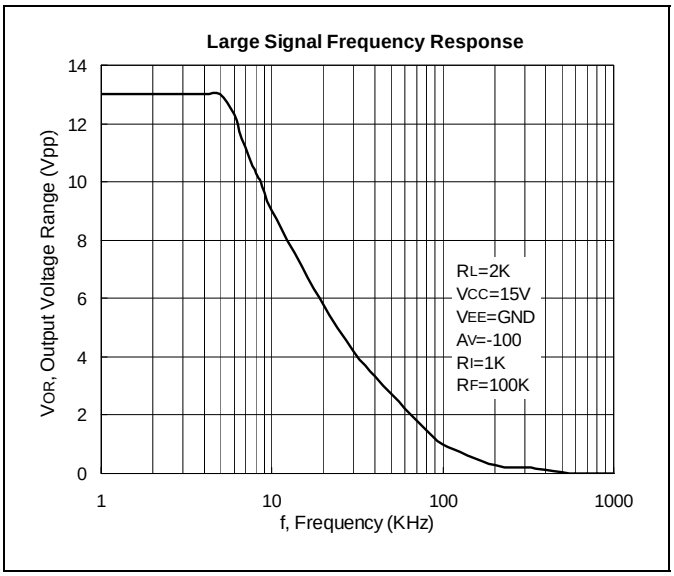
Symbol	Parameter	Range	Units
V_{CC}	Power Supply Voltage (Single Supply)	32	V_{DC}
V_{CC}, V_{EE}	Power Supply Voltage (Split Supplies)	±16	V_{DC}
V_{IDR}	Input Differential Voltage Range	±32	V_{DC}
V_{ICR}	Input Common Mode Voltage Range	-0.3 to +32	V_{DC}
t_{SC}	Output Short Circuit Duration	Continuous	
T_J	Junction Temperature	150	°C
T_{stg}	Storage Temperature Range	-55 to +125	°C
T_A	Operating Ambient Temperature Range	-5 to +85	°C
P_D	Maximum Power Dissipation (DIP-8) Maximum Power Dissipation (SO-8)	800 500	mW

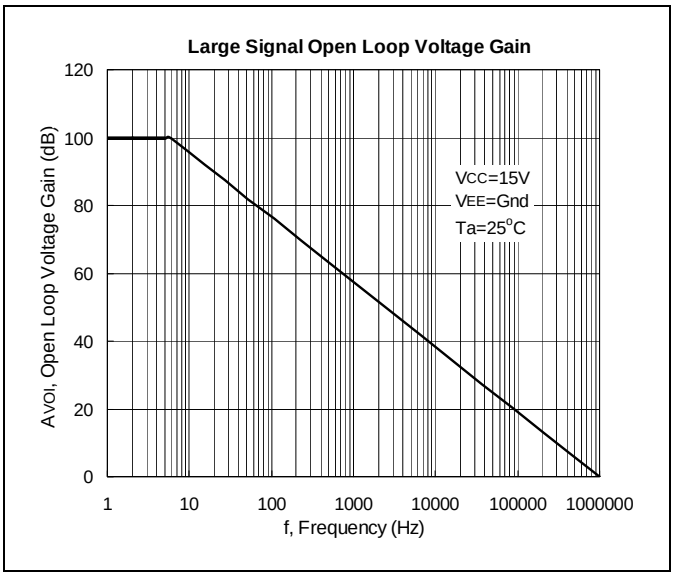
Electrical Characteristics (V_{CC}=5V, V_{EE}=Ground, Ta=25°C, unless otherwise specified)

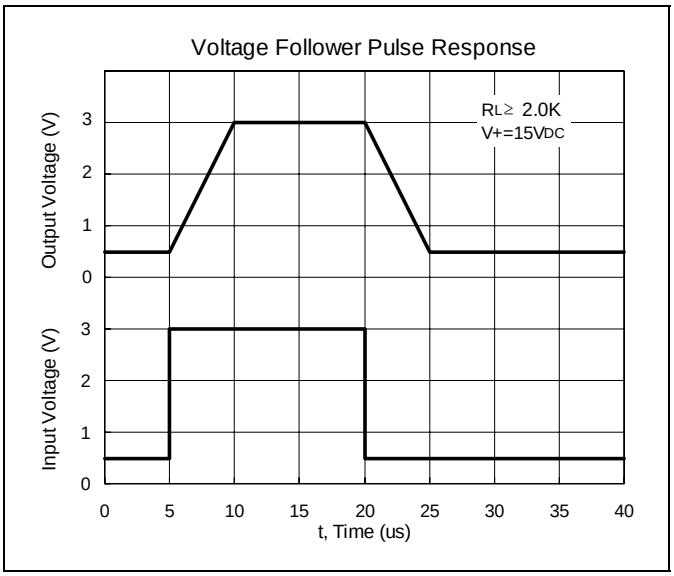
Symbol	Parameter	Test Conditions	LM358P/S			Unit
			Min	Typ	Max	
V_{IO}	Input Offset Voltage	V_{CC}=5V~30V, V_{ICR}=0V~V_{CC}-1.5V, V_O=1.4V, R_S=0Ω	-	2	7	mV
I_{IO}	Input Offset Current	$I_{IN(+)}$-$I_{IN(-)}$	-	-	30	nA
I_{IB}	Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$	-	35	200	nA
A_{VOL}	Large Signal Voltage Gain	V_{CC}=15V, R_L=2KΩ	25	100	-	V/mV
CMR	Common-Mode Rejection Ratio	V_{CM}=0V~V_{CC}-1.5V	65	85	-	dB
CS	Channel Separation	1KHz≤f≤20KHz	-	-120	-	dB
PSR	Power Supply Rejection	V_{CC}=5V~30V	65	100	-	dB
$\Delta V_{IO}/\Delta T$	Average Temperature Coefficient of Input Offset Voltage	R_S=0Ω	-	7	-	uV/°C
$\Delta I_{IO}/\Delta T$	Average Temperature Coefficient of Input Offset Current	R_S=0Ω	-	10	-	pA/°C
V_{ICR}	Input Common Mode Voltage Range	V_{CC}=30V			V_{CC}-2V	V
V_{OH}	Output Voltage (High Limit)	V_{CC}=30V, R_L=2KΩ	26	27	-	V
		V_{CC}=30V, R_L=10KΩ	27	28	-	
V_{OL}	Output Voltage (Low Limit)	R_L=10KΩ	-	5	20	mV
I_{CC}	Supply current	R_L=∞,V_{CC}=30V	-	1	2	mA
I_{Source}	Output Source Current	V_{CC}=15V, V_{IN+}=1V, V_{IN-}=0V, V_O=2V	20	40	-	mA
I_{Sink}	Output Sink Current	V_{CC}=15V, V_{IN+}=0V, V_{IN-}=1V, V_O=2V	10	20	-	mA
I_{CC}	Power Supply Current	V_{CC}=30V, Ta=T_{high} to T_{low}	-	1	2	mA
		V_{CC}=5V, Ta=T_{high} to T_{low}	-	0.6	1.2	mA
I_{SC}	Output Short Circuit to Ground	V_{CC}=5V, GND at -5V, V_O=0V	-	4		

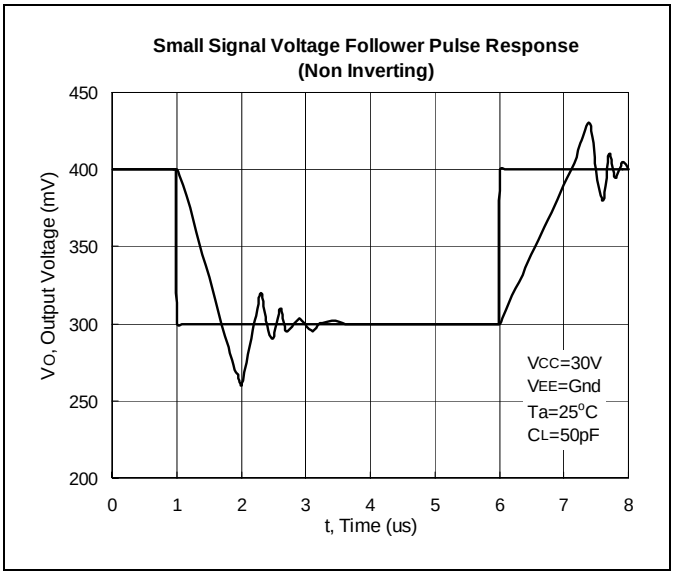
Characteristics Curve

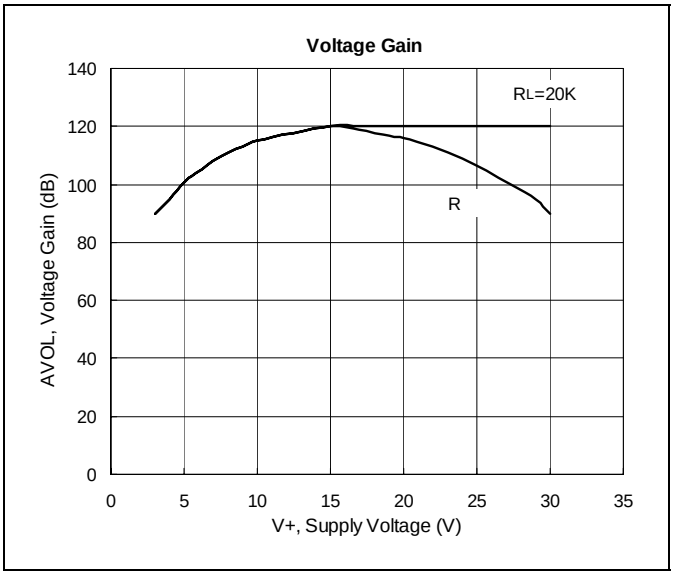




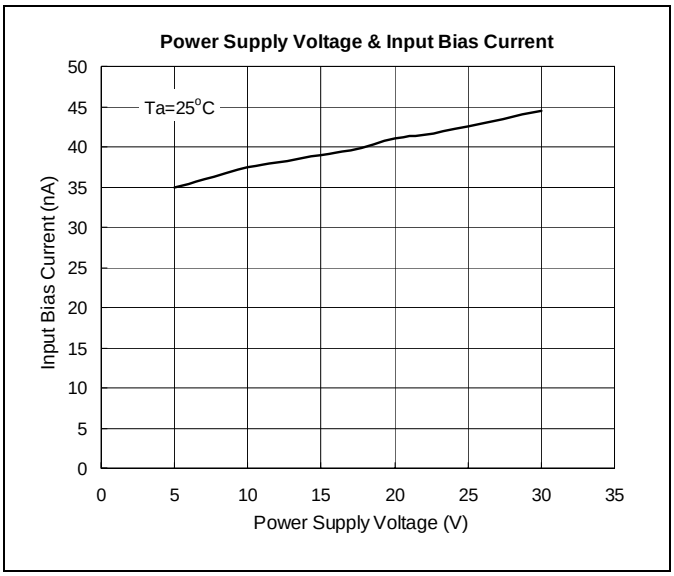


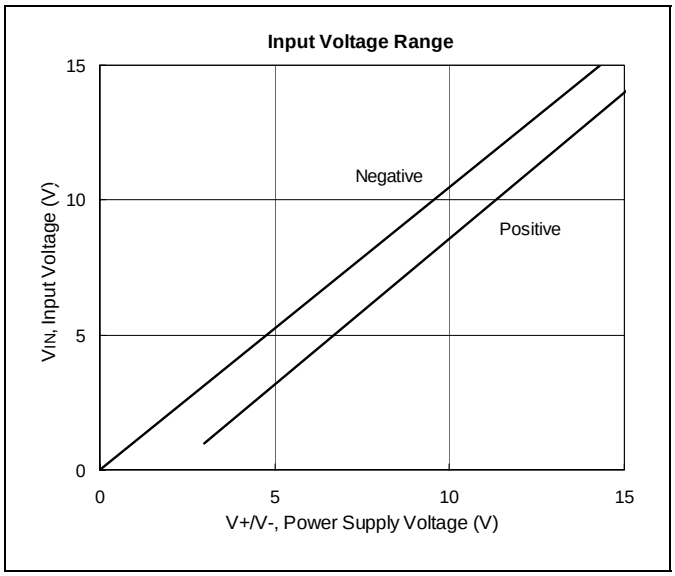






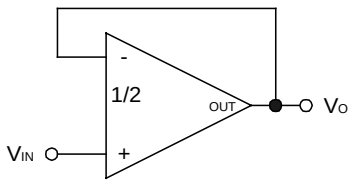
Characteristics Curve



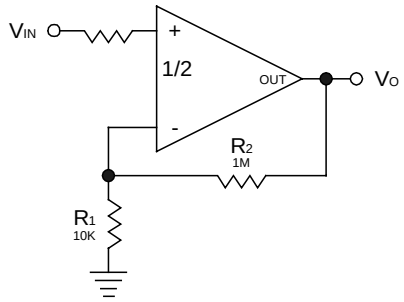


Typical Application Circuit

Voltage Follower

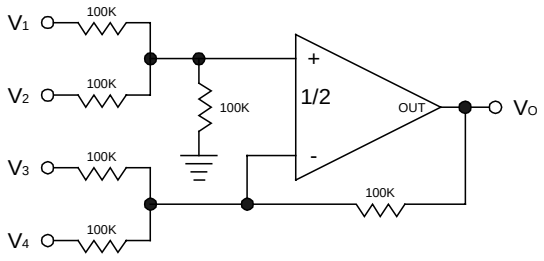


Non Inverting DC Amplifier



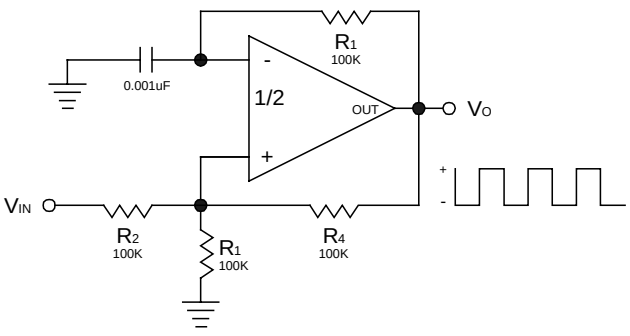
$A_V=1+R_1/R_2$

DC Summing Amplifier



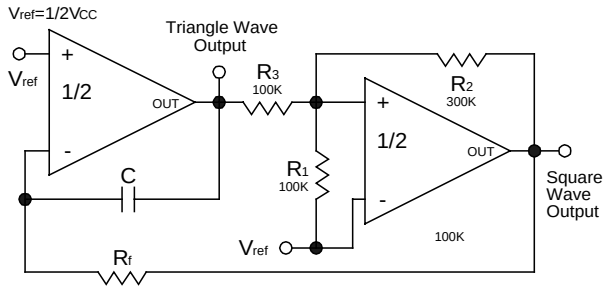
$V_O=V_1+V_2-V_3-V_4$
Where $(V_1+V_2)\geq(V_3+V_4)$
To keep $V_O\geq 0V$

Squarewave Oscillator



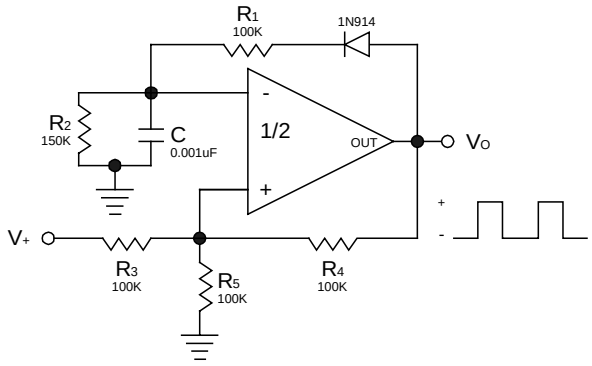
Typical Application Circuit

Function Generator

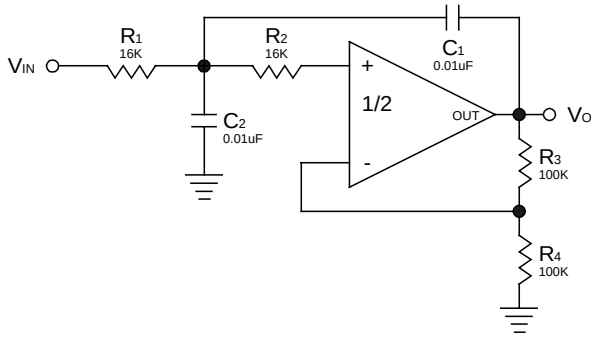


$F=(R_1+R_C)/4CR_fR_1$
if $R_3=R_2*R_1/(R_2+R_1)$

Pulse Generator

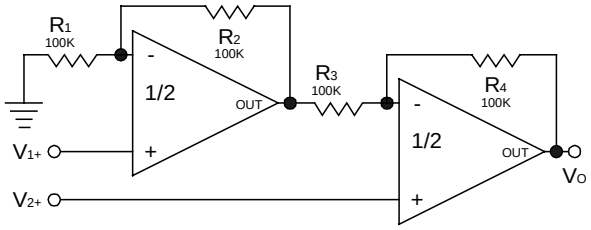


DC Coupled Low-Pass RC Active Filter



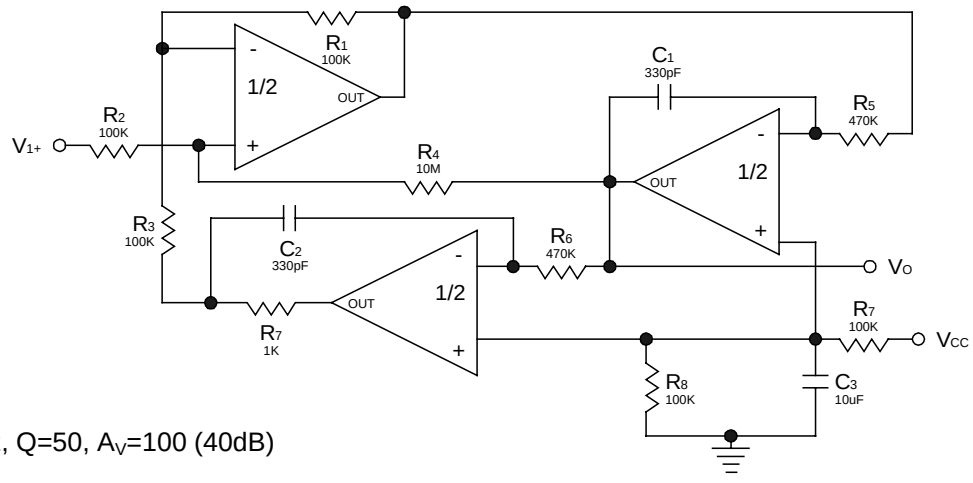
f_0=1KHz, Q=1, A_V=2

High Input Z, DC Differential Amplifier



$R_1/R_2=R_4/R_3$
$V_O=1+R_4/R_3(V_2-V_1)$
As shown $V_O=2(V_2-V_1)$

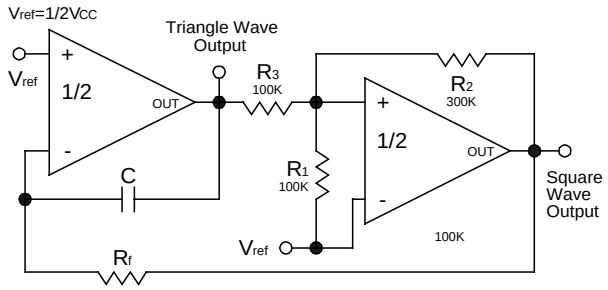
Active Band-Pass Filter



f_0=1KHz, Q=50, A_V=100 (40dB)

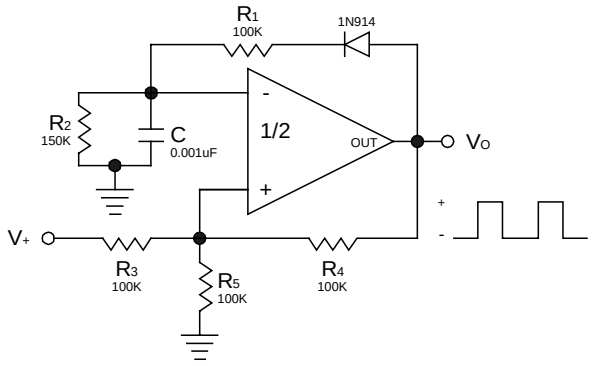
Typical Application Circuit

Function Generator



$F=(R_1+R_C)/4CR_fR_1$
if $R_3=R_2*R_1/(R_2+R_1)$

Pulse Generator



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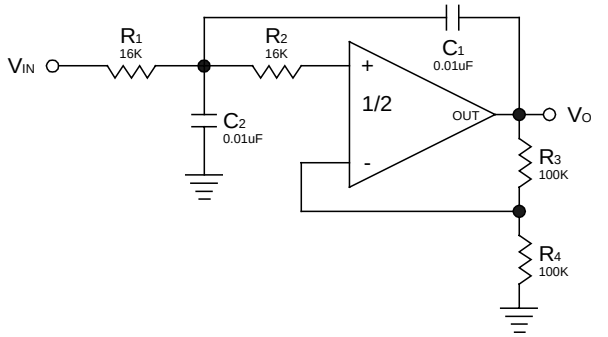

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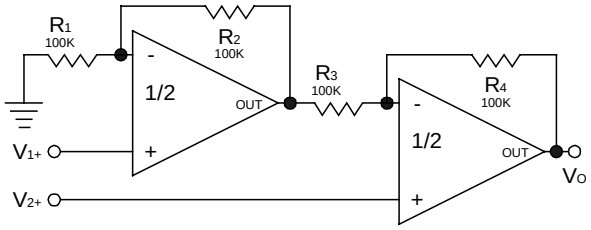
High Input Z, DC Differential Amplifier



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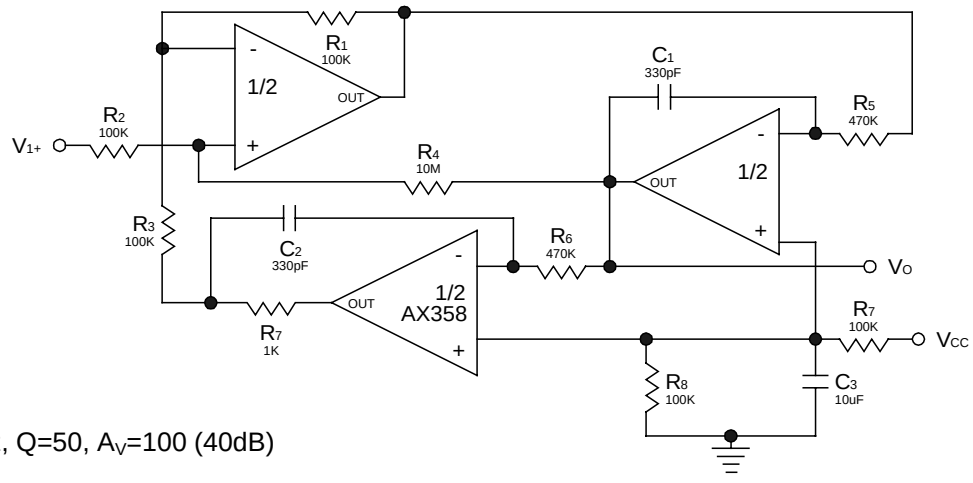
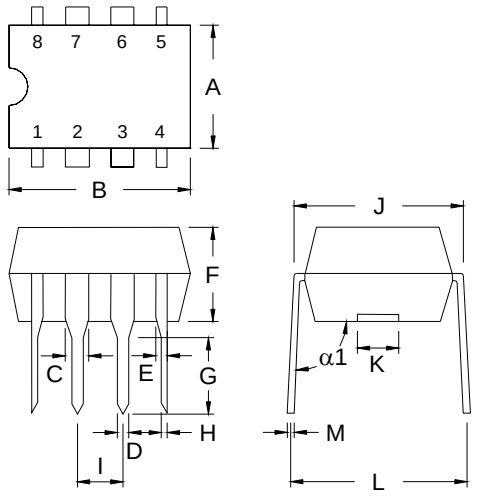


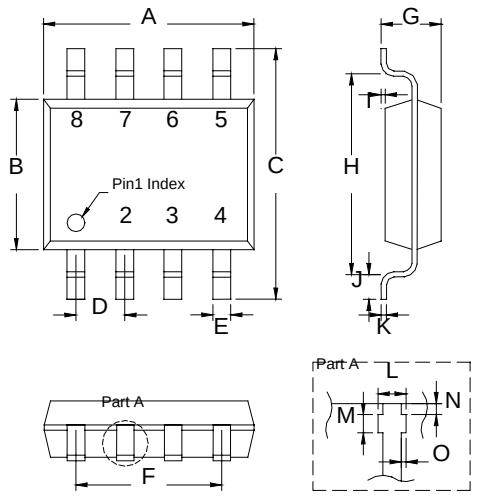
f_0=1KHz, Q=50, A_V=100 (40dB)



8-Lead DIP-8
Plastic Package
Code: P

A	6.29	6.40
B	9.22	9.32
C	-	*1.52
D	-	*1.27
E	-	*0.99
F	3.25	3.35
G	3.17	3.55
H	0.38	0.53
I	2.28	2.79
J	7.49	7.74
K	-	*3.00
L	8.56	8.81
M	0.229	0.381
α1	94°	97°

*: Typical, Unit: mm



DIM	Min.	Max.
A	4.85	5.10
B	3.85	3.95
C	5.80	6.20
D	1.22	1.32
E	0.37	0.47
F	3.74	3.88
G	1.45	1.65
H	4.80	5.10
I	0.05	0.20
J	0.30	0.70
K	0.19	0.25
L	0.37	0.52
M	0.23	0.28
N	0.08	0.13
O	0.00	0.15

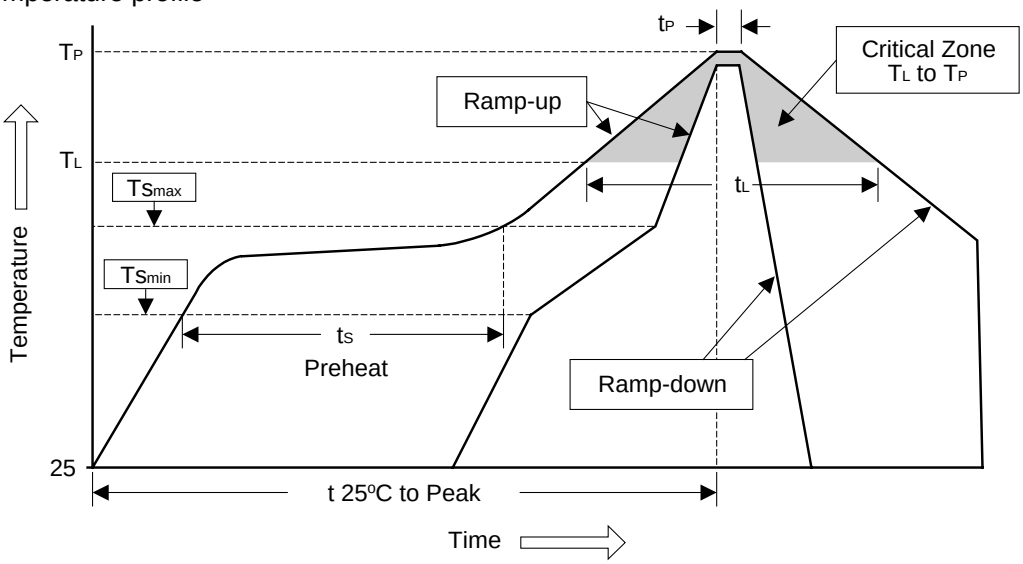
*: Typical, Unit: mm

Soldering Methods for Products

1. Storage environment: Humidity=65%±15%

2. Reflow soldering of surface-mount devices

Figure 1: Temperature profile



Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	<3°C/sec	<3°C/sec
Preheat - Temperature Min (Ts_{min}) - Temperature Max (Ts_{max}) - Time (min to max) (ts)	 100°C 150°C 60~120 sec	 150°C 200°C 60~180 sec
Tsmax to T_L - Ramp-up Rate	 <3°C/sec	 <3°C/sec
Time maintained above: - Temperature (T_L) - Time (t_L)	 183°C 60~150 sec	 217°C 60~150 sec
Peak Temperature (T_P)	240°C +0/-5°C	260°C +0/-5°C
Time within 5°C of actual Peak Temperature (t_P)	10~30 sec	20~40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<8 minutes

3. Flow (wave) soldering (solder dipping)

Products	Peak temperature	Dipping time
Pb devices.	245°C ±5°C	5sec ±1sec
Pb-Free devices.	260°C +0/-5°C	5sec ±1sec