



# HLM358P / HLM358S

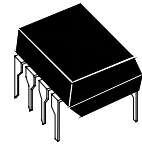
## LOW POWER DUAL OPERATIONAL AMPLIFIERS

### Description

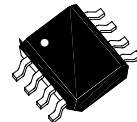
These devices consist of two independent, high gain, internally frequency-compensated operational amplifiers designed operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3V to 32V, and  $V_{CC}$  is at 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  $V_{CC}-1.5V_{DC}$

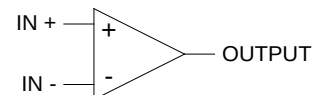


8-Lead Plastic **DIP-8**  
Package Code: P



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

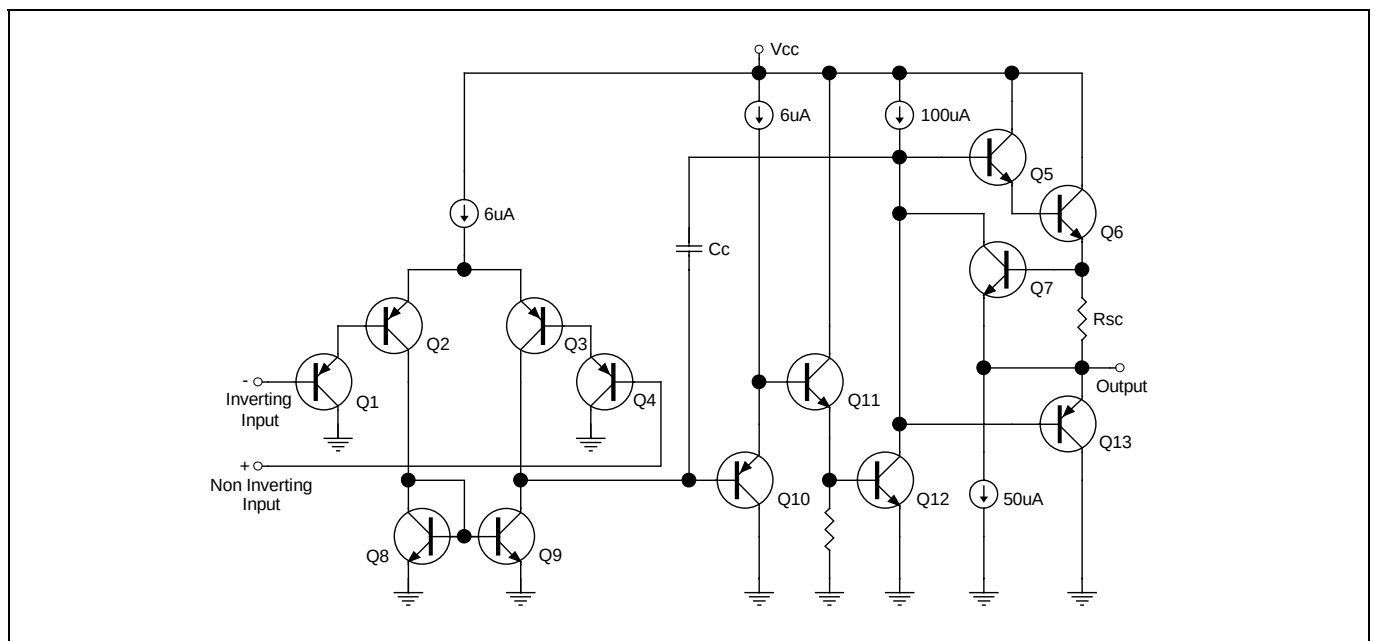
### Logic Diagram (each amplifier)



### 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 : $V_{CC}$              |

### Schematic Diagram





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

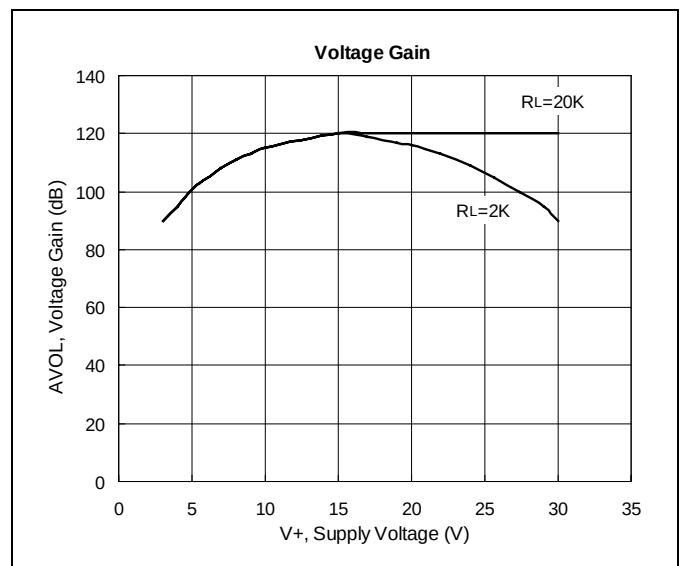
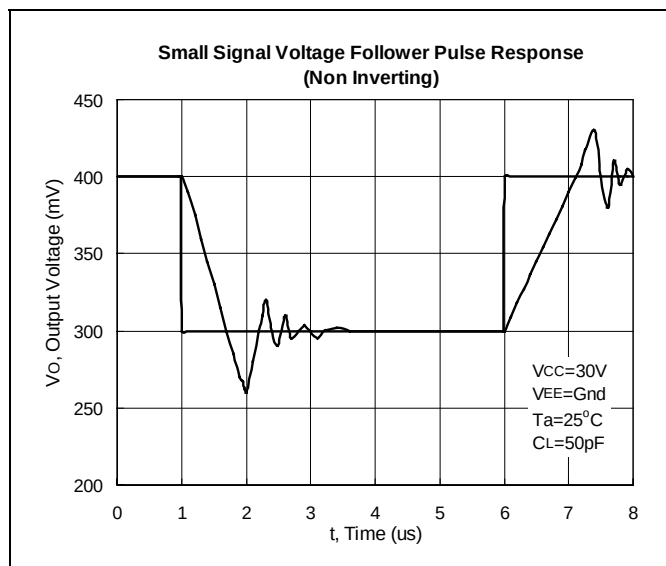
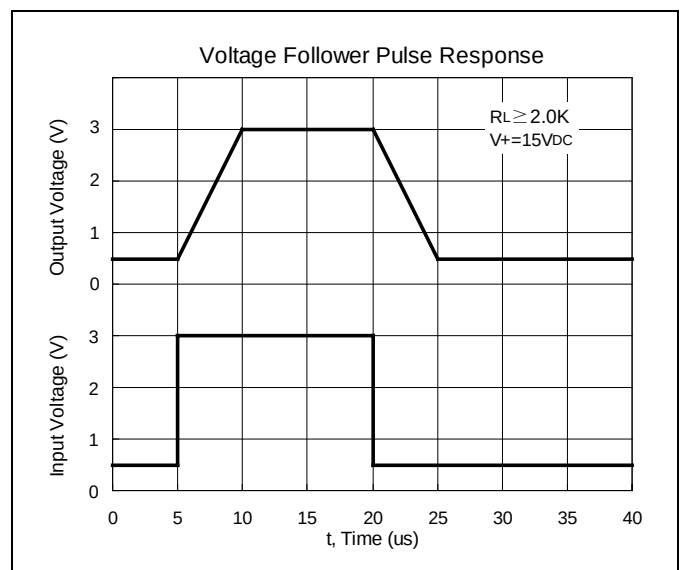
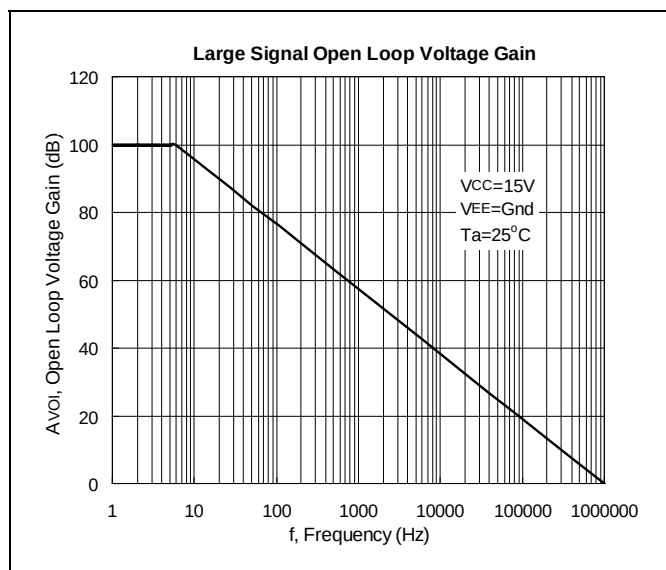
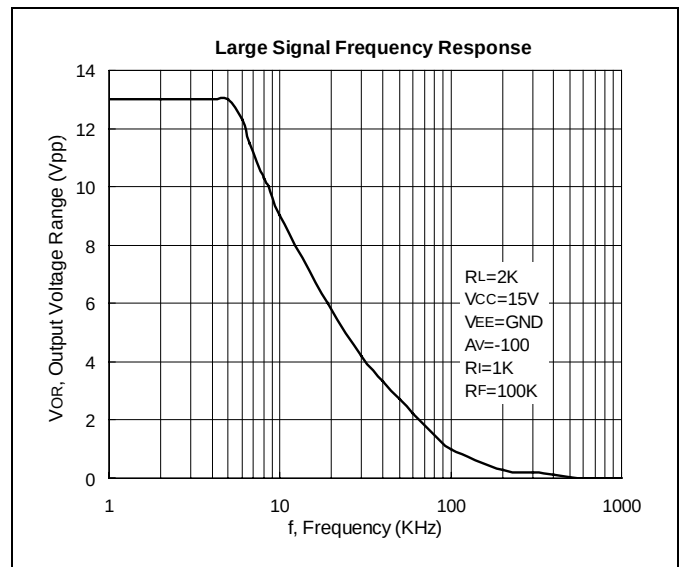
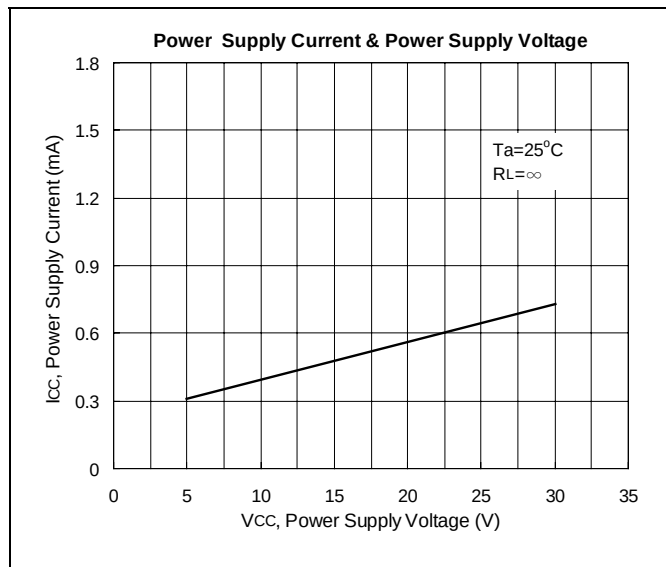
| Symbol           | Parameter                                                             | Range       | Units    |
|------------------|-----------------------------------------------------------------------|-------------|----------|
| $V_{CC}$         | Power Supply Voltage (Single Supply)                                  | 32          | $V_{DC}$ |
| $V_{CC}, V_{EE}$ | Power Supply Voltage (Split Supplies)                                 | $\pm 16$    | $V_{DC}$ |
| $V_{IDR}$        | Input Differential Voltage Range                                      | $\pm 32$    | $V_{DC}$ |
| $V_{ICR}$        | 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                                   | 0 to +70    | °C       |
| $P_D$            | Maximum Power Dissipation (DIP-8)<br>Maximum Power Dissipation (SO-8) | 800<br>500  | mW       |

### Electrical Characteristics ( $V_{CC}=5V$ , $V_{EE}=\text{Ground}$ , $T_a=25^\circ\text{C}$ , unless otherwise specified)

| Symbol                   | Parameter                                               | Test Conditions                                                                    | HLM358P/S |      |             | Unit                   |
|--------------------------|---------------------------------------------------------|------------------------------------------------------------------------------------|-----------|------|-------------|------------------------|
|                          |                                                         |                                                                                    | Min       | Typ  | Max         |                        |
| $V_{IO}$                 | Input Offset Voltage                                    | $V_{CC}=5V\sim 30V$ , $V_{ICR}=0V\sim V_{CC}-1.5V$ ,<br>$V_O=1.4V$ , $R_S=0\Omega$ | -         | 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                               | $V_{CC}=15V$ , $R_L=2K\Omega$                                                      | 25        | 100  | -           | V/mV                   |
| CMR                      | Common-Mode Rejection Ratio                             | $V_{CM}=0V\sim V_{CC}-1.5V$                                                        | 65        | 85   | -           | dB                     |
| CS                       | Channel Separation                                      | $1KHz \leq f \leq 20KHz$                                                           | -         | -120 | -           | dB                     |
| PSR                      | Power Supply Rejection                                  | $V_{CC}=5V\sim 30V$                                                                | 65        | 100  | -           | dB                     |
| $\Delta V_{IO}/\Delta T$ | Average Temperature Coefficient of Input Offset Voltage | $R_S=0\Omega$                                                                      | -         | 7    | -           | $\mu V/^\circ\text{C}$ |
| $\Delta I_{IO}/\Delta T$ | Average Temperature Coefficient of Input Offset Current | $R_S=0\Omega$                                                                      | -         | 10   | -           | $pA/^\circ\text{C}$    |
| $V_{ICR}$                | Input Common Mode Voltage Range                         | $V_{CC}=30V$                                                                       |           |      | $V_{CC}-2V$ | V                      |
| $V_{OH}$                 | Output Voltage (High Limit)                             | $V_{CC}=30V$ , $R_L=2K\Omega$                                                      | 26        | 27   | -           | V                      |
|                          |                                                         | $V_{CC}=30V$ , $R_L=10K\Omega$                                                     | 27        | 28   | -           |                        |
| $V_{OL}$                 | Output Voltage (Low Limit)                              | $R_L=10K\Omega$                                                                    | -         | 5    | 20          | mV                     |
| $I_{CC}$                 | Supply current                                          | $R_L=\infty$ , $V_{CC}=30V$                                                        | -         | 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                                    | $V_{CC}=30V$ , $T_a=T_{high}$ to $T_{low}$                                         | -         | 1    | 2           | mA                     |
|                          |                                                         | $V_{CC}=5V$ , $T_a=T_{high}$ to $T_{low}$                                          | -         | 0.6  | 1.2         | mA                     |
| $I_{SC}$                 | Output Short Circuit to Ground                          | $V_{CC}=5V$ , GND at -5V, $V_O=0V$                                                 | -         | 40   | 60          | mA                     |

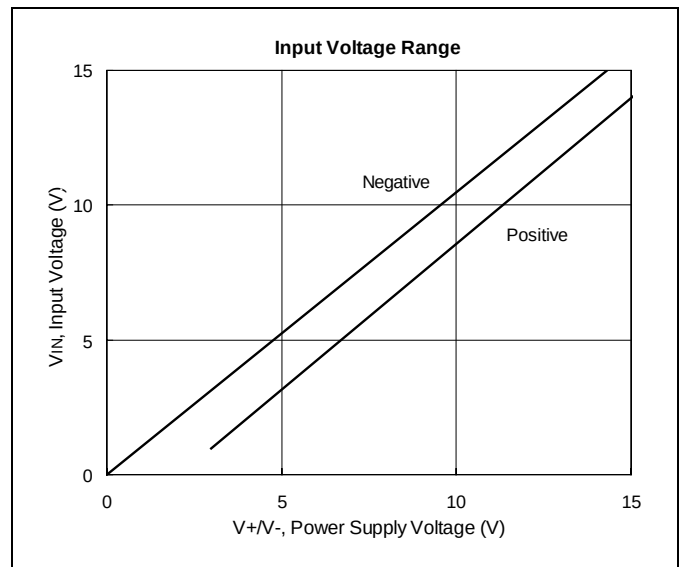
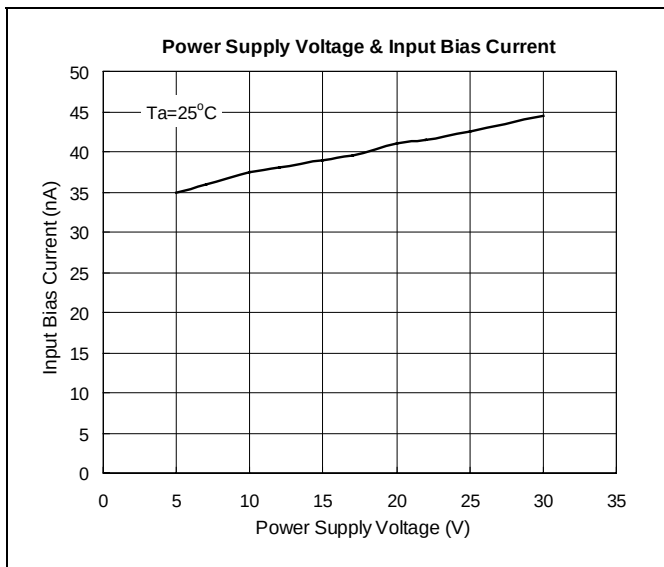


### Characteristics Curve

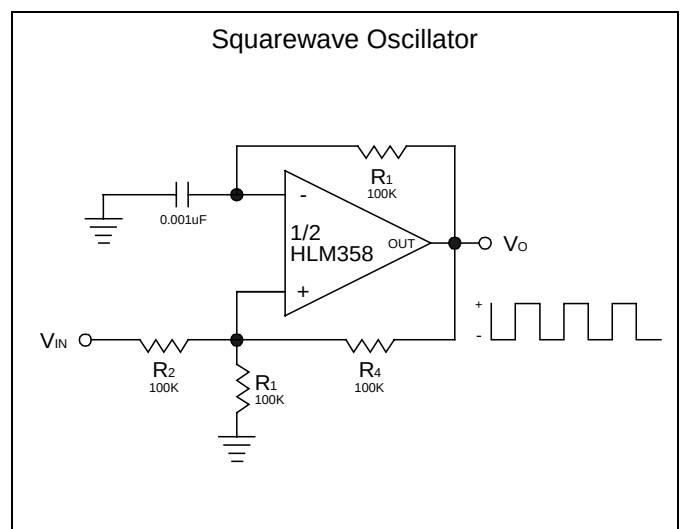
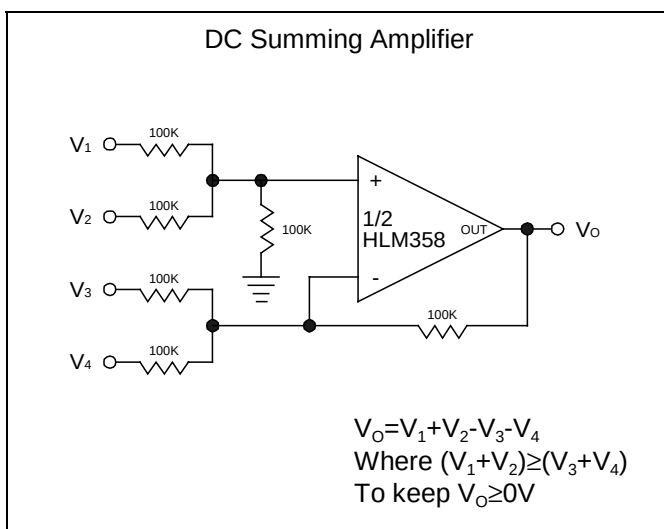
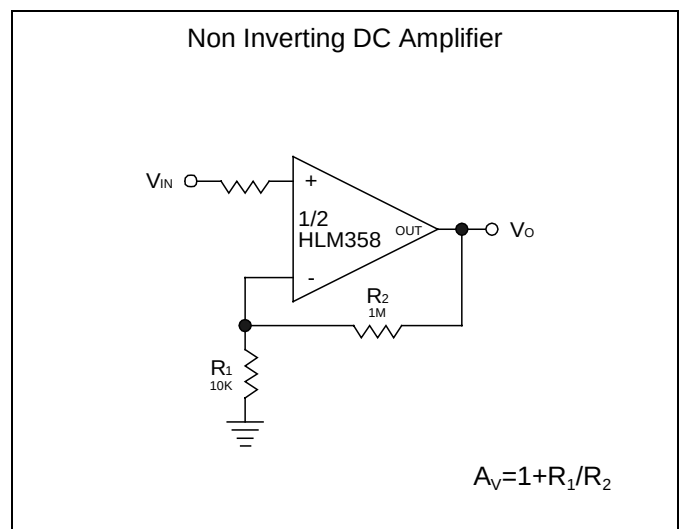
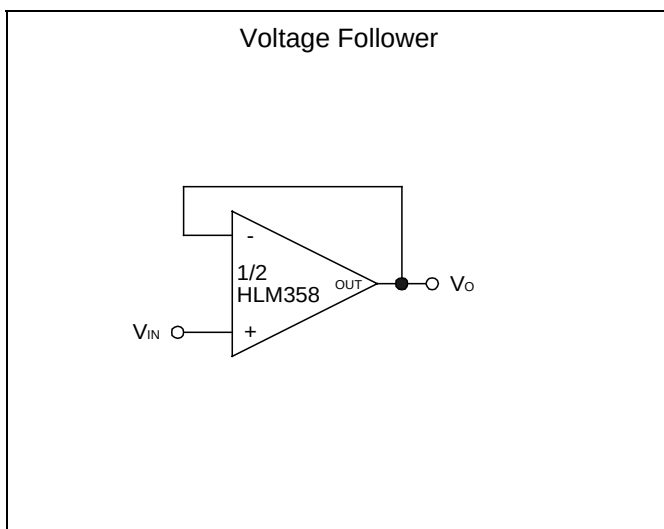




### Characteristics Curve



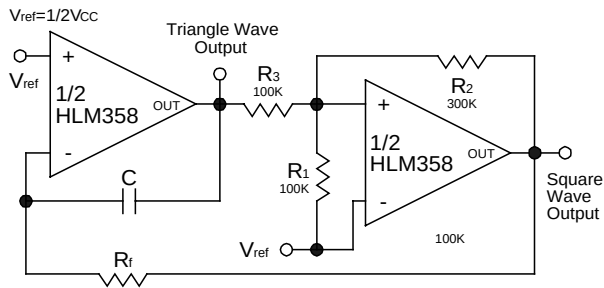
### Typical Application Circuit





### Typical Application Circuit

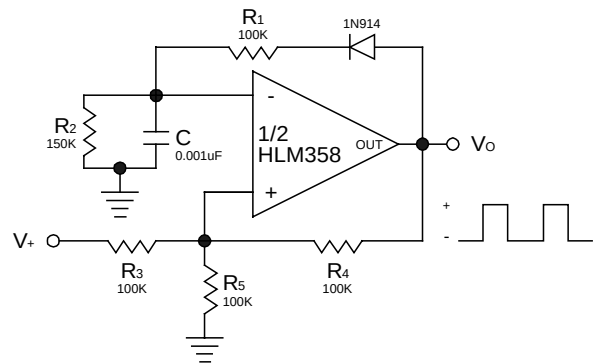
Function Generator



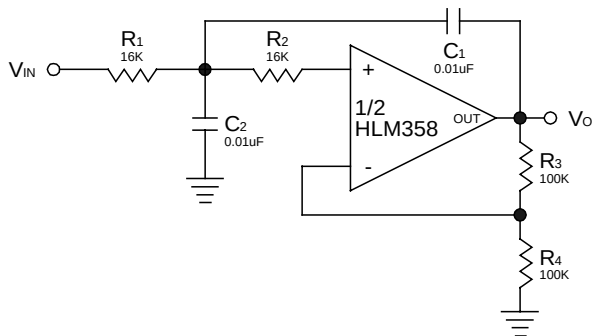
$$F = (R_1 + R_C) / 4CR_f R_1$$

if  $R_3 = R_2 * R_1 / (R_2 + R_1)$

Pulse Generator

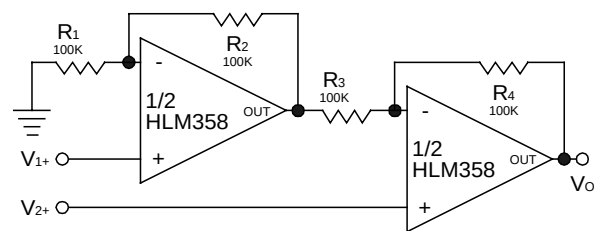


DC Coupled Low-Pass RC Active Filter



$$f_0 = 1\text{KHz}, Q=1, A_v=2$$

High Input Z, DC Differential Amplifier

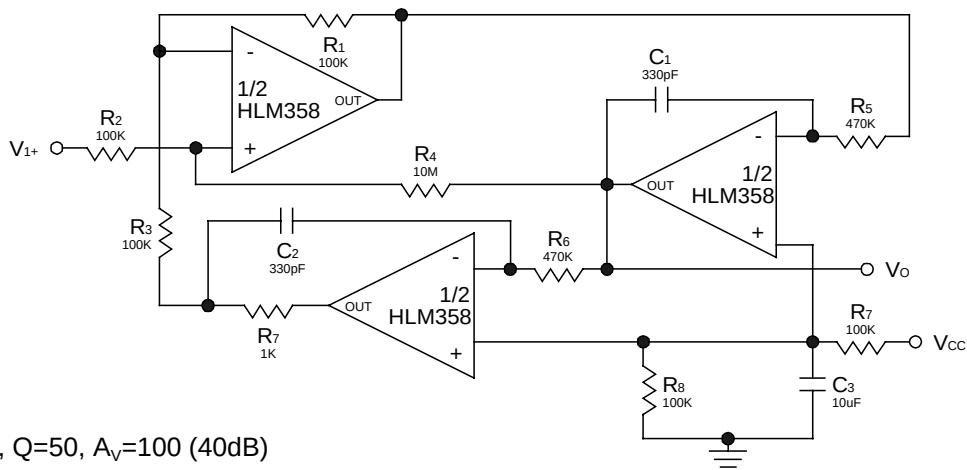


$$R_1/R_2 = R_4/R_3$$

$$V_O = 1 + R_4/R_3 (V_2 - V_1)$$

As shown  $V_O = 2(V_2 - V_1)$

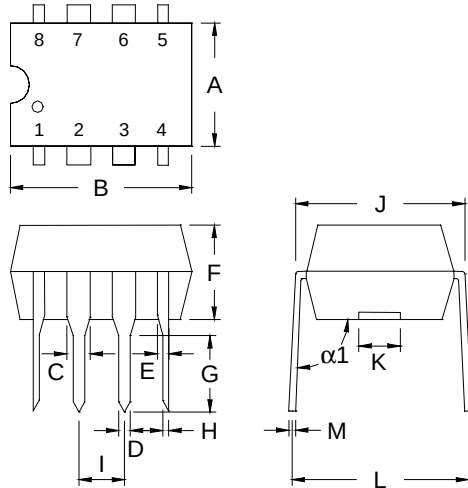
Active Band-Pass Filter



$$f_0 = 1\text{KHz}, Q=50, A_v=100 (40\text{dB})$$

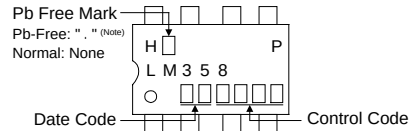


### DIP-8 Dimension



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

#### Marking:



Note: Green label is used for pb-free packing

Pin Style: 1.Output 1 2.Inverting input 1  
3.Non inverting input 1 4.V<sub>EE</sub>  
5.Non inverting input 2  
6.Inverting input 2 7. Output 2 8.V<sub>CC</sub>

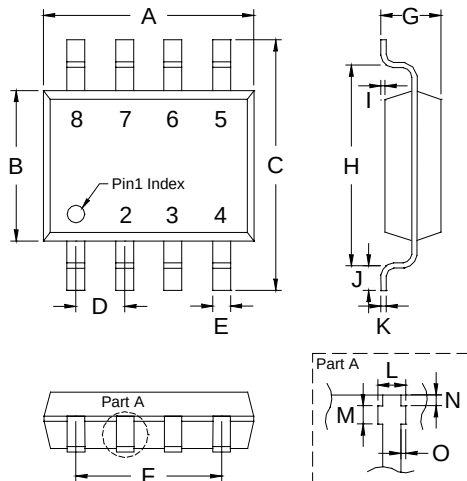
#### Material:

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

| DIM        | Min.  | Max.  |
|------------|-------|-------|
| 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 |
| $\alpha 1$ | 94°   | 97°   |

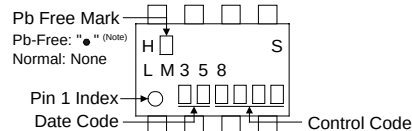
\*: Typical, Unit: mm

### SO-8 Dimension



8-Lead SO-8 Plastic  
Surface Mounted Package  
HSMC Package Code: S

#### Marking:



Note: Green label is used for pb-free packing

Pin Style: 1.Output 1 2.Inverting input 1  
3.Non inverting input 1 4.V<sub>EE</sub>  
5.Non inverting input 2  
6.Inverting input 2 7. Output 2 8.V<sub>CC</sub>

#### Material:

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

| 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

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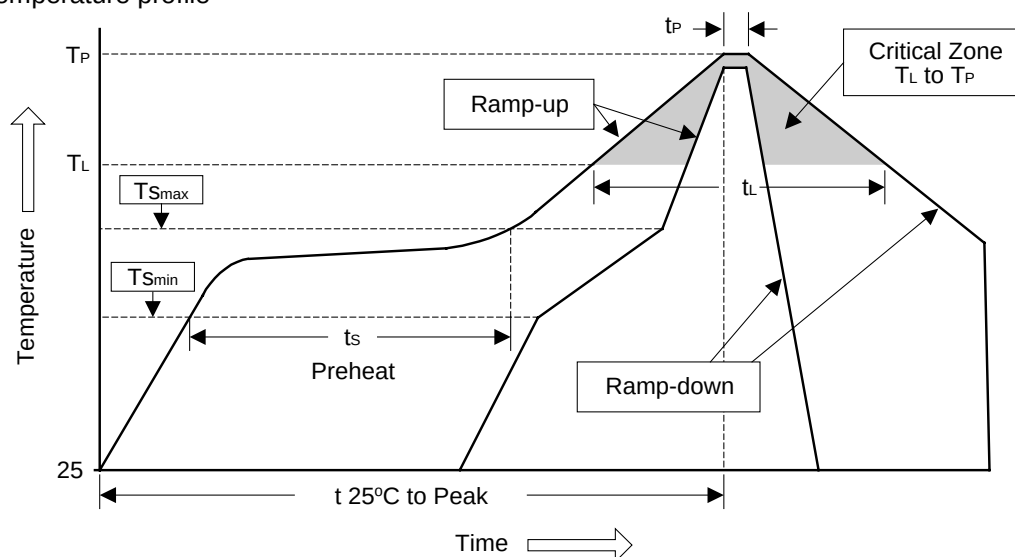
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## Soldering Methods for HSMC's Products

1. Storage environment: Temperature=10°C~35°C 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 ( $T_{smin}$ )                     | 100°C                   | 150°C            |
| - Temperature Max ( $T_{smax}$ )                     | 150°C                   | 200°C            |
| - Time (min to max) ( $t_s$ )                        | 60~120 sec              | 60~180 sec       |
| $T_{smax}$ to $T_L$                                  |                         |                  |
| - Ramp-up Rate                                       | <3°C/sec                | <3°C/sec         |
| Time maintained above:                               |                         |                  |
| - Temperature ( $T_L$ )                              | 183°C                   | 217°C            |
| - Time ( $t_L$ )                                     | 60~150 sec              | 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   |