

# MC3458, MC3358

## Dual, Low Power Operational Amplifiers

Utilizing the circuit designs perfected for the quad operational amplifiers, these dual operational amplifiers feature: low power drain, a common mode input voltage range extending to ground/ $V_{EE}$ , and Single Supply or Split Supply operation.

These amplifiers have several distinct advantages over standard operational amplifier types in single supply applications. They can operate at supply voltages as low as 3.0 V or as high as 36 V with quiescent currents about one-fifth of those associated with the MC1741C (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

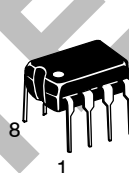
- Short Circuit Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 36 V
- Low Input Bias Currents
- Internally Compensated
- Common Mode Range Extends to Negative Supply
- Class AB Output Stage for Minimum Crossover Distortion
- Single and Split Supply Operations Available
- Similar Performance to the Popular MC1458



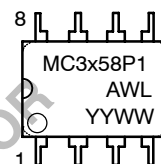
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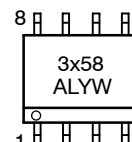
### MARKING DIAGRAMS



**PDIP-8**  
**P1 SUFFIX**  
**CASE 626**

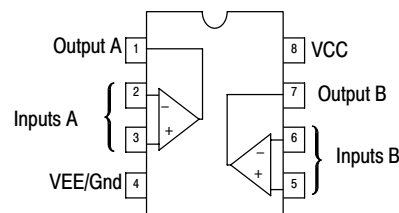


**SO-8**  
**D SUFFIX**  
**CASE 751**



x = 3 or 4  
A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week

### PIN CONNECTIONS

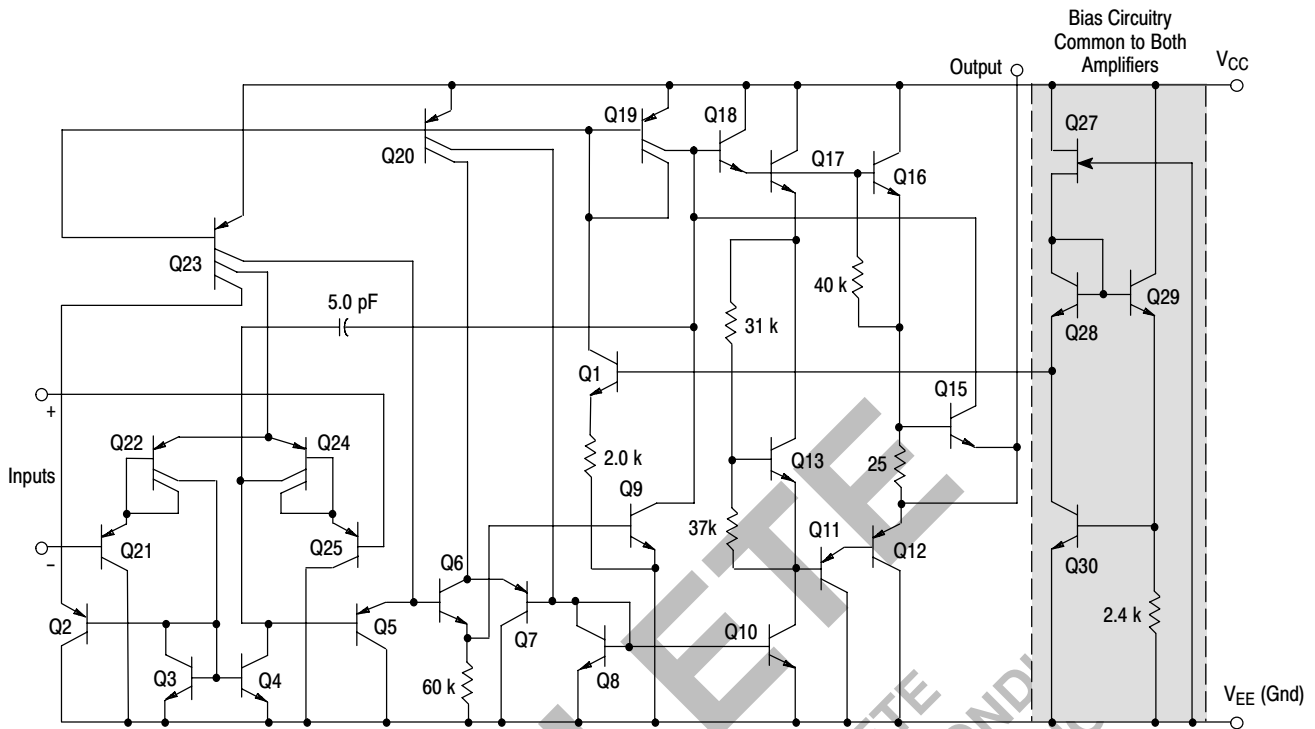


(Top View)

### ORDERING INFORMATION

| Device    | Package | Shipping         |
|-----------|---------|------------------|
| MC3358D   | SO-8    | 98 Units/Rail    |
| MC3358DR2 | SO-8    | 2500 Tape & Reel |
| MC3358P1  | PDIP-8  | 50 Units/Rail    |
| MC3458D   | SO-8    | 98 Units/Rail    |
| MC3458DR2 | SO-8    | 2500 Tape & Reel |
| MC3458P1  | PDIP-8  | 50 Units/Rail    |

# MC3458, MC3358



**Figure 1. Representative Schematic Diagram**  
(1/2 of Circuit Shown)

## MAXIMUM RATINGS

| Rating                                    | Symbol           | Value       | Unit        |
|---|------------------|-------------|-------------|
| Power Supply Voltages                     |                  |             | Vdc         |
| Single Supply                             | $V_{CC}$         | 36          |             |
| Split Supplies                            | $V_{CC}, V_{EE}$ | $\pm 18$    |             |
| Input Differential Voltage Range (Note 1) | $V_{IDR}$        | $\pm 30$    | Vdc         |
| Input Common Mode Voltage Range (Note 2)  | $V_{ICR}$        | $\pm 15$    | Vdc         |
| Junction Temperature                      | $T_J$            | 150         | $^{\circ}C$ |
| Storage Temperature Range                 | $T_{stg}$        | -55 to +125 | $^{\circ}C$ |
| Operating Ambient Temperature Range       | $T_A$            |             | $^{\circ}C$ |
| MC3458                                    |                  | 0 to +70    |             |
| MC3358                                    |                  | -40 to +85  |             |

1. Split Power Supplies.
2. For supply voltages less than  $\pm 18$  V, the absolute maximum input voltage is equal to the supply voltage.

# MC3458, MC3358

**ELECTRICAL CHARACTERISTICS** (For MC3458,  $V_{CC} = +15\text{ V}$ ,  $V_{EE} = -15\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)  
 (For MC3358,  $V_{CC} = +14\text{ V}$ ,  $V_{EE} = \text{Gnd}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

| Characteristic  | Symbol                   | MC3458     |            |          | MC3358     |            |          | Unit                         |
|---|--------------------------|------------|------------|----------|------------|------------|----------|------------------------------|
|   |                          | Min        | Typ        | Max      | Min        | Typ        | Max      |                              |
| Input Offset Voltage<br>$T_A = T_{\text{high}}$ to $T_{\text{low}}$ (Note 3)  | $V_{IO}$                 | –          | 2.0        | 10       | –          | 2.0        | 8.0      | mV                           |
|   |                          | –          | –          | 12       | –          | –          | 10       |                              |
| Input Offset Current<br>$T_A = T_{\text{high}}$ to $T_{\text{low}}$   | $I_{IO}$                 | –          | 30         | 50       | –          | 30         | 75       | nA                           |
|   |                          | –          | –          | 200      | –          | –          | 250      |                              |
| Large Signal Open Loop Voltage Gain<br>$V_O = \pm 10\text{ V}$ , $R_L = 2.0\text{ k}\Omega$ ,<br>$T_A = T_{\text{high}}$ to $T_{\text{low}}$                | $A_{VOL}$                | 20         | 200        | –        | 20         | 200        | –        | V/mV                         |
|   |                          | 15         | –          | –        | 15         | –          | –        |                              |
| Input Bias Current<br>$T_A = T_{\text{high}}$ to $T_{\text{low}}$   | $I_{IB}$                 | –          | –200       | –500     | –          | –200       | –500     | nA                           |
|   |                          | –          | –          | –800     | –          | –          | –1000    |                              |
| Output Impedance, $f = 20\text{ Hz}$  | $z_O$                    | –          | 75         | –        | –          | 75         | –        | $\Omega$                     |
| Input Impedance, $f = 20\text{ Hz}$   | $z_I$                    | 0.3        | 1.0        | –        | 0.3        | 1.0        | –        | $M\Omega$                    |
| Output Voltage Range<br>$R_L = 10\text{ k}\Omega$<br>$R_L = 2.0\text{ k}\Omega$<br>$R_L = 2.0\text{ k}\Omega$ , $T_A = T_{\text{high}}$ to $T_{\text{low}}$ | $V_{OR}$                 | $\pm 12$   | $\pm 13.5$ | –        | 12         | 12.5       | –        | V                            |
|   |                          | $\pm 10$   | $\pm 13$   | –        | 10         | 12         | –        |                              |
|   |                          | $\pm 10$   | –          | –        | 10         | –          | –        |                              |
| Input Common Mode Voltage Range   | $V_{ICR}$                | +13        | +13.5      | –        | +13        | +13.5      | –        | V                            |
|   |                          | – $V_{EE}$ | – $V_{EE}$ | –        | – $V_{EE}$ | – $V_{EE}$ | –        |                              |
| Common Mode Rejection Ratio, $R_S \leq 10\text{ k}\Omega$   | CMR                      | 70         | 90         | –        | 70         | 90         | –        | dB                           |
| Power Supply Current ( $V_O = 0$ ) $R_L = \infty$   | $I_{CC}$ , $I_{EE}$      | –          | 1.6        | 3.7      | –          | 1.6        | 3.7      | mA                           |
| Individual Output Short Circuit Current (Note 4)  | $I_{SC}$                 | $\pm 10$   | $\pm 20$   | $\pm 45$ | $\pm 10$   | $\pm 30$   | $\pm 45$ | mA                           |
| Positive Power Supply Rejection Ratio   | PSRR+                    | –          | 30         | 150      | –          | 30         | 150      | $\mu\text{V/V}$              |
| Negative Power Supply Rejection Ratio   | PSRR–                    | –          | 30         | 150      | –          | –          | –        | $\mu\text{V/V}$              |
| Average Temperature Coefficient of Input Offset Current, $T_A = T_{\text{high}}$ to $T_{\text{low}}$  | $\Delta I_{IO}/\Delta T$ | –          | 50         | –        | –          | 50         | –        | $\text{pA}/^\circ\text{C}$   |
| Average Temperature Coefficient of Input Offset Current, $T_A = T_{\text{high}}$ to $T_{\text{low}}$  | $\Delta V_{IO}/\Delta T$ | –          | 10         | –        | –          | 10         | –        | $\mu\text{V}/^\circ\text{C}$ |
| Power Bandwidth<br>$A_V = 1$ , $R_L = 2.0\text{ k}\Omega$ , $V_O = 20\text{ V}_{pp}$ , THD = 5%   | BWp                      | –          | 9.0        | –        | –          | 9.0        | –        | kHz                          |
| Small Signal Bandwidth<br>$A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 50\text{ mV}$  | BW                       | –          | 1.0        | –        | –          | 1.0        | –        | MHz                          |
| Slew Rate<br>$A_V = 1$ , $V_I = -10\text{ V}$ to $+10\text{ V}$   | SR                       | –          | 0.6        | –        | –          | 0.6        | –        | $\text{V}/\mu\text{s}$       |
| Rise Time<br>$A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 50\text{ mV}$   | $t_{TLH}$                | –          | 0.35       | –        | –          | 0.35       | –        | $\mu\text{s}$                |
| Fall Time<br>$A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 50\text{ mV}$   | $t_{THL}$                | –          | 0.35       | –        | –          | 0.35       | –        | $\mu\text{s}$                |
| Overshoot<br>$A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 50\text{ mV}$   | os                       | –          | 20         | –        | –          | 20         | –        | %                            |
| Phase Margin<br>$A_V = 1$ , $R_L = 2.0\text{ k}\Omega$ , $C_L = 200\text{ pF}$  | $\phi_m$                 | –          | 60         | –        | –          | 60         | –        | Degrees                      |
| Crossover Distortion<br>( $V_{in} = 30\text{ mV}_{pp}$ , $V_{out} = 2.0\text{ V}_{pp}$ , $f = 10\text{ kHz}$ )  | –                        | –          | 1.0        | –        | –          | 1.0        | –        | %                            |

3. MC3358:  $T_{\text{low}} = -40^\circ\text{C}$ ,  $T_{\text{high}} = +85^\circ\text{C}$   
 MC3458:  $T_{\text{low}} = 0^\circ\text{C}$ ,  $T_{\text{high}} = +70^\circ\text{C}$

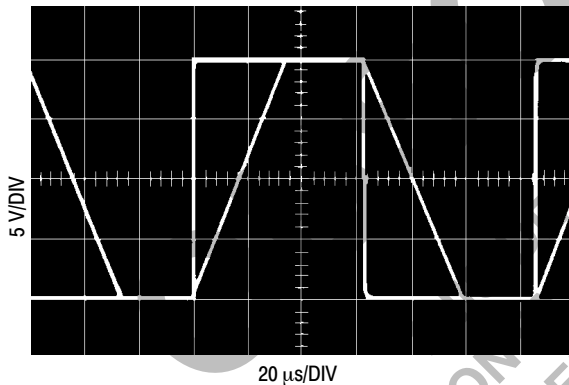
4. Not to exceed maximum package power dissipation.

# MC3458, MC3358

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = 5.0\text{ V}$ , $V_{EE} = \text{Gnd}$ , $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

| Characteristic  | Symbol    | MC3458 |                  |      | MC3358 |                  |      | Unit            |
|---|-----------|--------|------------------|------|--------|------------------|------|-----------------|
|   |           | Min    | Typ              | Max  | Min    | Typ              | Max  |                 |
| Input Offset Voltage  | $V_{IO}$  | –      | 2.0              | 5.0  | –      | 2.0              | 10   | mV              |
| Input Offset Current  | $I_{IO}$  | –      | 30               | 50   | –      | –                | 75   | nA              |
| Input Bias Current  | $I_{IB}$  | –      | –200             | –500 | –      | –                | –500 | nA              |
| Large Signal Open Loop Voltage Gain<br>$R_L = 2.0\text{ k}\Omega$ ,   | $A_{VOL}$ | 20     | 200              | –    | 20     | 200              | –    | V/mV            |
| Power Supply Rejection Ratio  | PSRR      | –      | –                | 150  | –      | –                | 150  | $\mu\text{V/V}$ |
| Output Voltage Range (Note 5)<br>$R_L = 10\text{ k}\Omega$ , $V_{CC} = 5.0\text{ V}$<br>$R_L = 10\text{ k}\Omega$ , $5.0\text{ V} \leq V_{CC} \leq 30\text{ V}$ | $V_{OR}$  | 3.3    | 3.5              | –    | 3.3    | 3.5              | –    | $V_{pp}$        |
|   |           | –      | $V_{CC}$<br>–1.7 | –    | –      | $V_{CC}$<br>–1.7 | –    |                 |
| Power Supply Current  | $I_{CC}$  | –      | 2.5              | 7.0  | –      | 2.5              | 4.0  | mA              |
| Channel Separation<br>$f = 1.0\text{ kHz to } 20\text{ kHz}$ (Input Referenced)   | CS        | –      | –120             | –    | –      | –120             | –    | dB              |

5. Output will swing to ground with a  $10\text{ k}\Omega$  pull down resistor.



**Figure 2. Inverter Pulse Response**

### CIRCUIT DESCRIPTION

The MC3458/3358 is made using two internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices Q24 and Q22 with input buffer transistors Q25 and Q21 and the differential to single ended converter Q3 and Q4. The first

stage performs not only the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance, a smaller compensation capacitor (only  $5.0\text{ pF}$ ) can be employed, thus saving chip area. The transconductance reduction is accomplished by splitting the collectors of Q24 and Q22. Another feature of this input stage is that the input Common Mode range can include the negative supply or ground, in single supply operation, without saturating either the input devices or the differential to single-ended converter. The second stage consists of a standard current source load amplifier stage.

The output stage is unique because it allows the output to swing to ground in single supply operation and yet does not exhibit any crossover distortion in split supply operation. This is possible because Class AB operation is utilized.

Each amplifier is biased from an internal voltage regulator which has a low temperature coefficient thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.

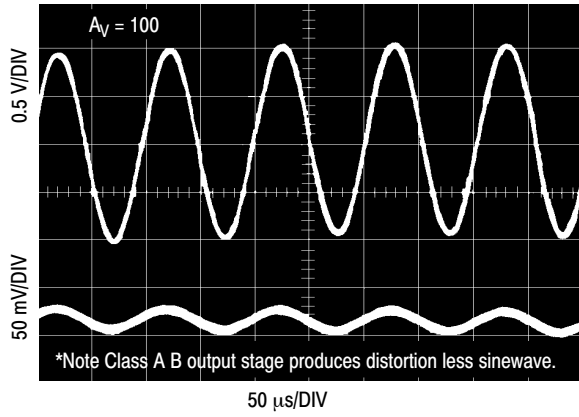


Figure 3. Sine Wave Response

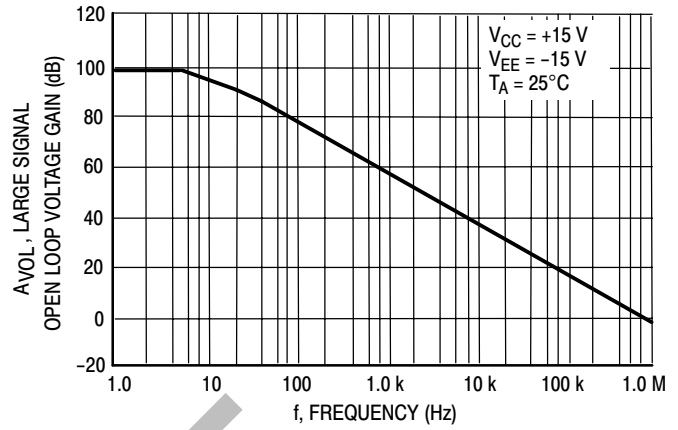


Figure 4. Open Loop Frequency Response

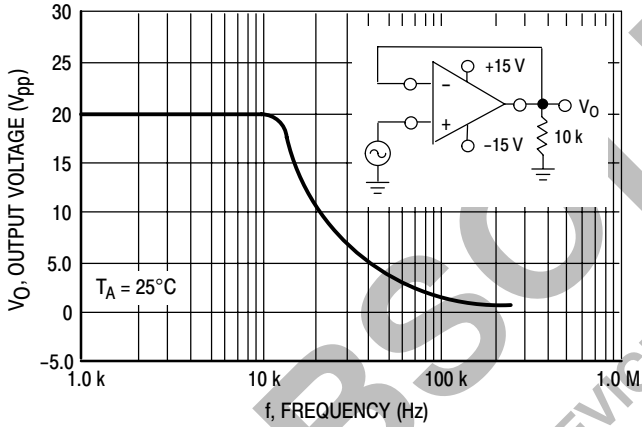


Figure 5. Power Bandwidth

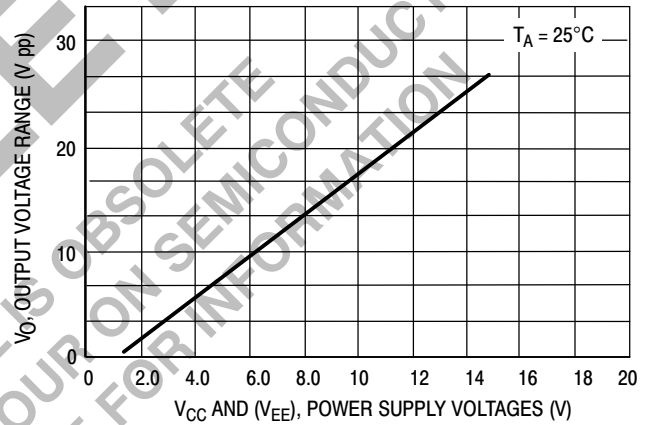


Figure 6. Output Swing versus Supply Voltage

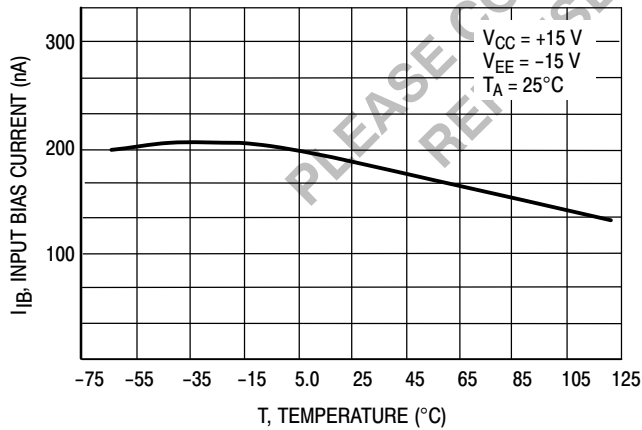


Figure 7. Input Bias Current versus Temperature

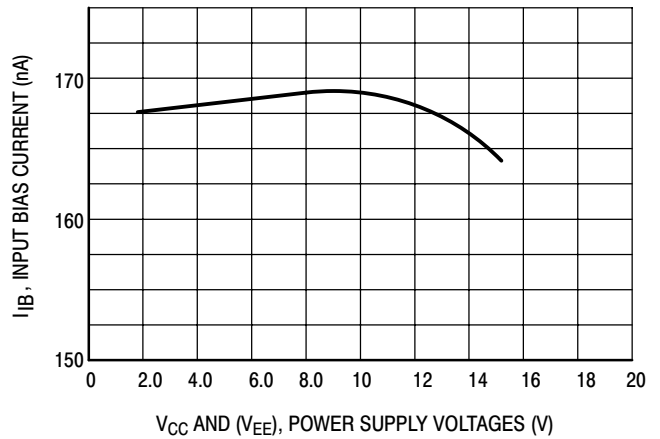


Figure 8. Input Bias Current versus Supply Voltage

# MC3458, MC3358

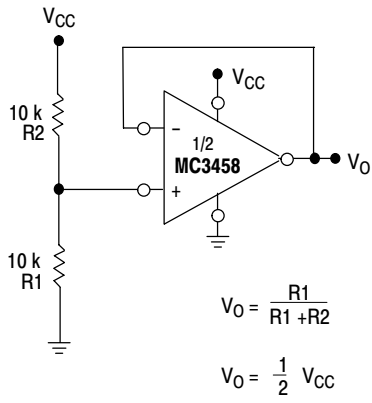


Figure 9. Voltage Reference

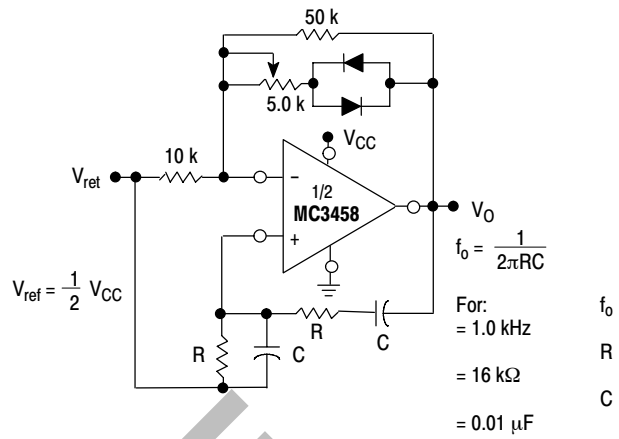


Figure 10. Wien Bridge Oscillator

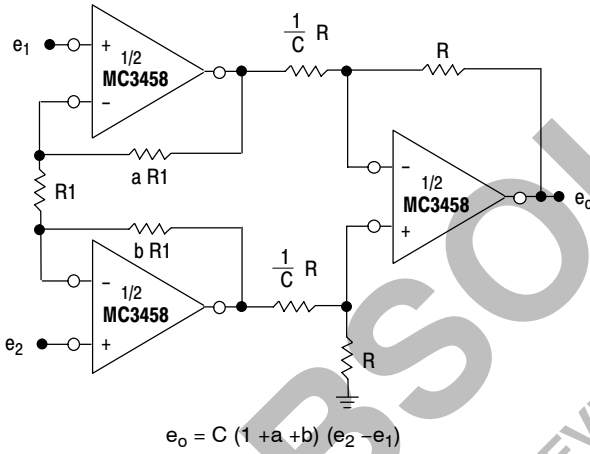


Figure 11. High Impedance Differential Amplifier

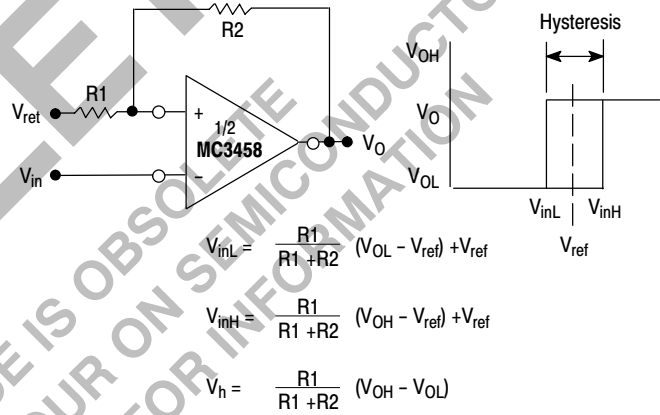


Figure 12. Comparator with Hysteresis

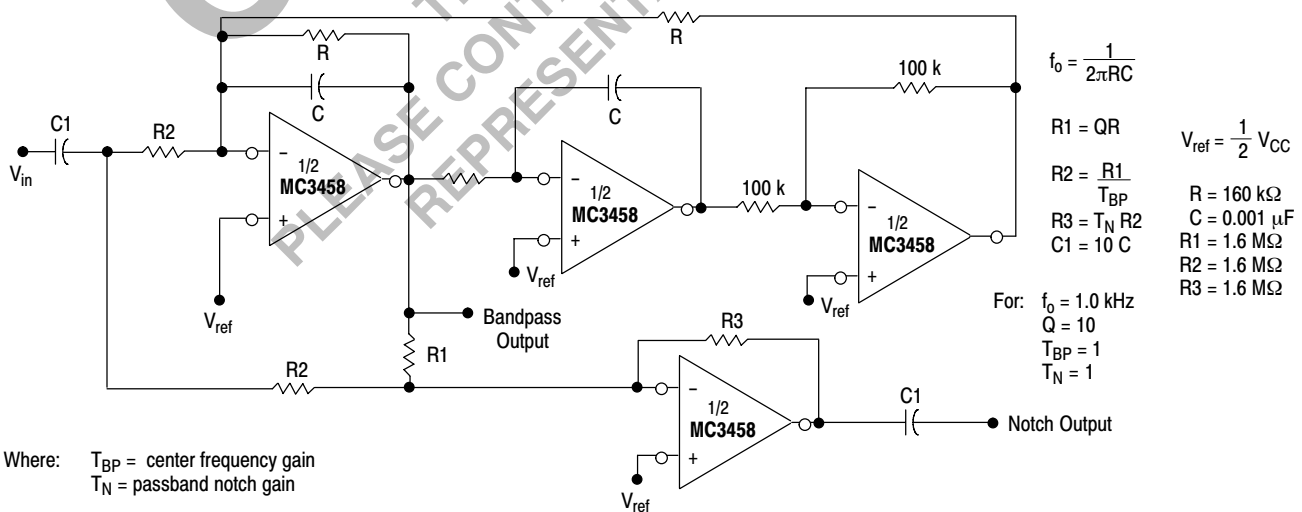


Figure 13. Bi-Quad Filter

## MC3458, MC3358

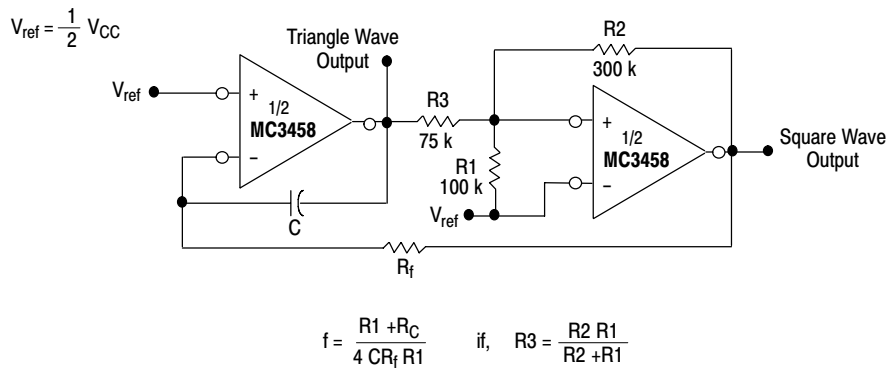
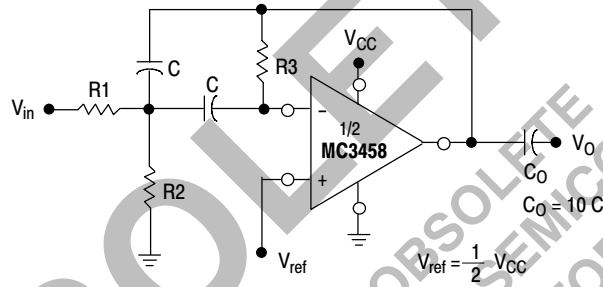


Figure 14. Function Generator



Given:  $f_0$  = center frequency  
 $A(f_0)$  = gain at center frequency

Choose value  $f_0$ ,  $C$ .

$$\text{Then: } R3 = \frac{Q}{\pi f_0 C} \quad R1 = \frac{R3}{2 A(f_0)} \quad R2 = \frac{R1 R5}{4Q^2 R1 - R3}$$

For less than 10% error from operational amplifier  $\frac{Q_0 f_0}{BW} < 0.1$

where,  $f_0$  and BW are expressed in Hz.

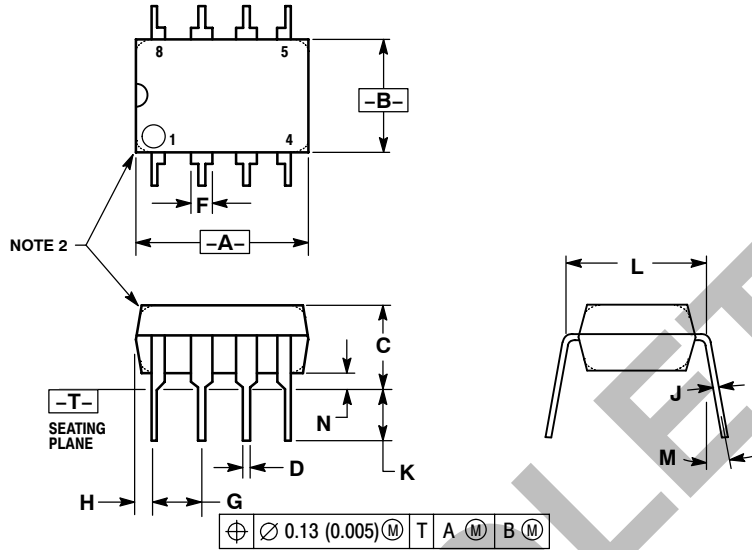
If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

Figure 15. Multiple Feedback Bandpass Filter

# MC3458, MC3358

## PACKAGE DIMENSIONS

PDIP-8  
P1 SUFFIX  
CASE 626-05  
ISSUE L

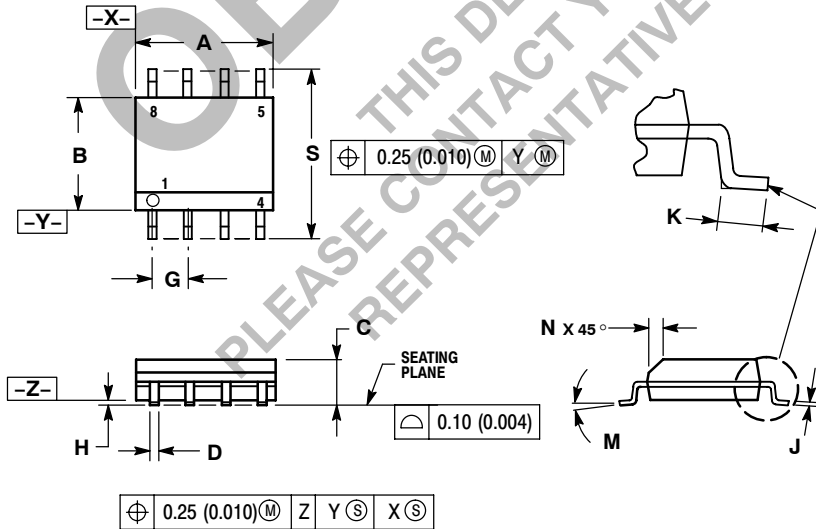


NOTES:

1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.40        | 10.16 | 0.370     | 0.400 |
| B   | 6.10        | 6.60  | 0.240     | 0.260 |
| C   | 3.94        | 4.45  | 0.155     | 0.175 |
| D   | 0.38        | 0.51  | 0.015     | 0.020 |
| F   | 1.02        | 1.78  | 0.040     | 0.070 |
| G   | 2.54 BSC    |       | 0.100 BSC |       |
| H   | 0.76        | 1.27  | 0.030     | 0.050 |
| J   | 0.20        | 0.30  | 0.008     | 0.012 |
| K   | 2.92        | 3.43  | 0.115     | 0.135 |
| L   | 7.62 BSC    |       | 0.300 BSC |       |
| M   | ---         |       | 10°       |       |
| N   | 0.76        | 1.01  | 0.030     | 0.040 |

SO-8  
D SUFFIX  
CASE 751-07  
ISSUE W



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.80        | 5.00 | 0.189     | 0.197 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.053     | 0.069 |
| D   | 0.33        | 0.51 | 0.013     | 0.020 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| H   | 0.10        | 0.25 | 0.004     | 0.010 |
| J   | 0.19        | 0.25 | 0.007     | 0.010 |
| K   | 0.40        | 1.27 | 0.016     | 0.050 |
| M   | 0°          |      | 8°        |       |
| N   | 0.25        | 0.50 | 0.010     | 0.020 |
| S   | 5.80        | 6.20 | 0.228     | 0.244 |



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