

## General Description

The WD358/358A consist of two independent, high gain and internally frequency compensated operational amplifiers, they are specifically designed to operate from a single power supply. Operation from split power supply is also possible and the low power supply current drain is independent of the magnitude of the power supply voltages. Typical applications include transducer amplifiers, DC gain blocks and most conventional operational amplifier circuits.

The WD358/358A series are compatible with industry standard 358. WD358A has more stringent input offset voltage than WD358.

The WD358 is available in DIP-8, SOIC-8 and TSSOP-8 packages, WD358A is available in DIP-8 and SOIC-8 packages.

## Features

- Internally Frequency Compensated for Unity Gain
- Large Voltage Gain: 100dB (Typical)
- Low Input Bias Current: 20nA (Typical)
- Low Input Offset Voltage: 2mV (Typical)
- Low Supply Current: 0.5mA (Typical)
- Wide Power Supply Voltage:
  - Single Supply: 3V to 36V
  - Dual Supplies:  $\pm 1.5V$  to  $\pm 18V$
- Input Common Mode Voltage Range Includes Ground
- Large Output Voltage Swing: 0V to  $V_{CC}-1.5V$

## Applications

- Battery Charger
- Cordless Telephone
- Switching Power Supply

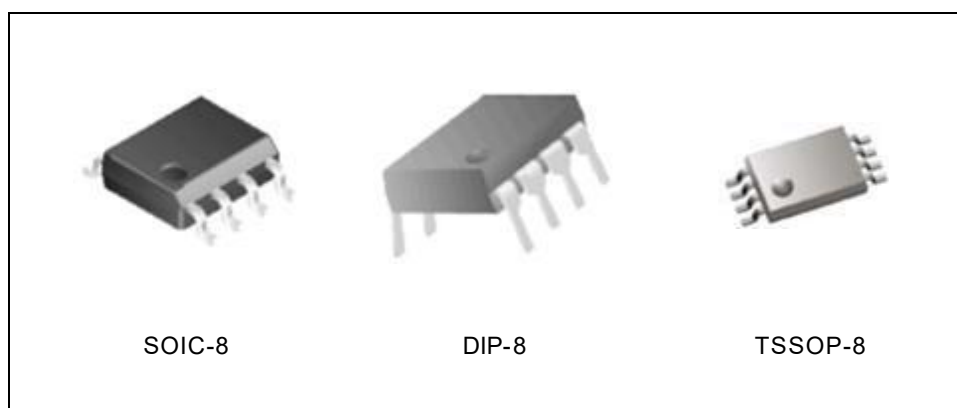


Figure 1. Package Types of WD358/358A

## Pin Configuration

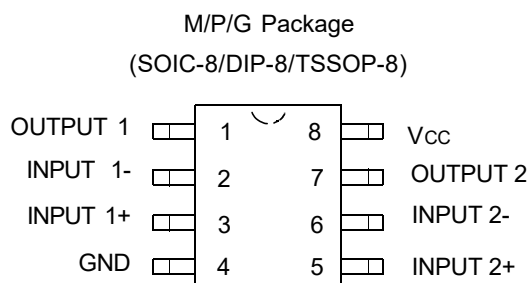


Figure 2. Pin Configuration of WD358/358A (Top View)

## Functional Block Diagram

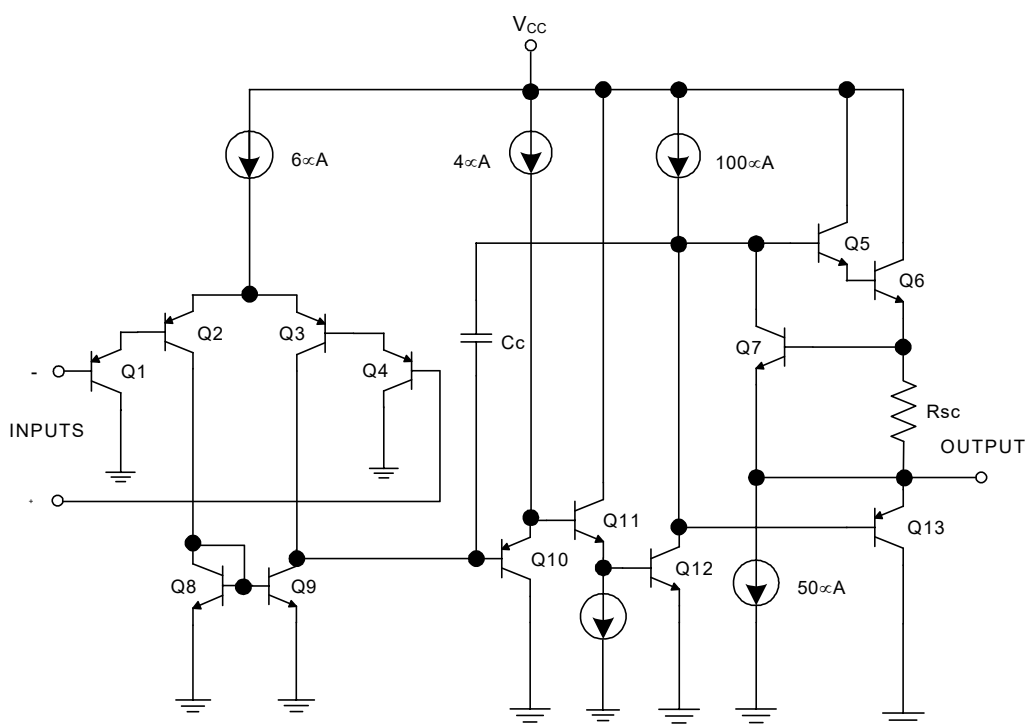
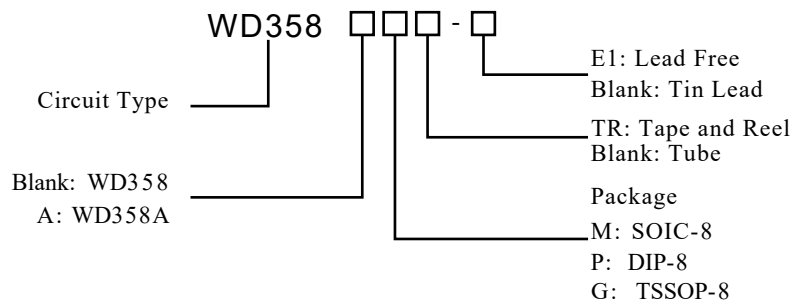


Figure 3. Functional Block Diagram of  
WD358/358A (Each Amplifier)

## Ordering Information



| Package | Temperature Range | Part Number |              | Marking ID |            | Packing Type |
|---------|-------------------|-------------|--------------|------------|------------|--------------|
|         |                   | Tin Lead    | Lead Free    | Tin Lead   | Lead Free  |              |
| SOIC-8  | -40 to 85°C       | WD358M      | WD358M-E1    | WD358M     | WD358M-E1  | Tube         |
|         |                   | WD358MTR    | WD358MTR-E1  | WD358M     | WD358M-E1  | Tape & Reel  |
|         |                   |             | WD358AM-E1   |            | WD358AM-E1 | Tube         |
|         |                   |             | WD358AMTR-E1 |            | WD358AM-E1 | Tape & Reel  |
| DIP-8   |                   | WD358P      | WD358P-E1    | WD358P     | WD358P-E1  | Tube         |
|         |                   |             | WD358AP-E1   |            | WD358AP-E1 | Tube         |
| TSSOP-8 |                   |             | WD358G-E1    |            | EG3 A      | Tube         |
|         |                   |             | WD358GTR-E1  |            | EG3 A      | Tape & Reel  |

## Absolute Maximum Ratings (Note 1)

| Parameter                                | Symbol    | Value      |     | Unit |
|------------------------------------------|-----------|------------|-----|------|
| Power Supply Voltage                     | $V_{CC}$  | 40         |     | V    |
| Differential Input Voltage               | $V_{ID}$  | 40         |     | V    |
| Input Voltage                            | $V_{IC}$  | -0.3 to 40 |     | V    |
| Power Dissipation                        | $P_D$     | DIP-8      | 830 | mW   |
|                                          |           | SOIC-8     | 550 |      |
|                                          |           | TSSOP-8    | 500 |      |
| Storage Temperature Range                | $T_{STG}$ | -65 to 150 |     | °C   |
| Lead Temperature (Soldering, 10 Seconds) |           | 260        |     | °C   |
| ESD (Machine Model)                      | ESD       | 200        |     | V    |

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

## Recommended Operating Conditions

| Parameter                           | Symbol   | Min | Max | Unit |
|-------------------------------------|----------|-----|-----|------|
| Supply Voltage                      | $V_{CC}$ | 3   | 36  | V    |
| Ambient Operating Temperature Range | $T_A$    | -40 | 85  | °C   |

## Electrical Characteristics

Limits in standard typeface are for  $T_A=25^{\circ}\text{C}$ , bold typeface applies over  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  (Note 2),  $V_{CC} = 5\text{V}$ ,  $\text{GND}=0\text{V}$ , unless otherwise specified.

| Parameter                                               | Symbol                   | Conditions                                                                                       |        | Min | Typ  | Max          | Unit                           |
|---------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------|--------|-----|------|--------------|--------------------------------|
| Input Offset Voltage                                    | $V_{IO}$                 | $V_O = 1.4\text{V}$ , $R_S = 0\Omega$ ,<br>$V_{CC} = 5\text{V}$ to $30\text{V}$                  | WD358  |     | 2    | 5            | mV                             |
|                                                         |                          |                                                                                                  |        |     |      | <b>7</b>     |                                |
|                                                         |                          |                                                                                                  | WD358A |     | 2    | 3            |                                |
|                                                         |                          |                                                                                                  |        |     |      | <b>5</b>     |                                |
| Average Temperature Coefficient of Input Offset Voltage | $\Delta V_{IO}/\Delta T$ | $T_A = -40$ to $85^{\circ}\text{C}$                                                              |        |     | 7    |              | $\mu\text{V}/^{\circ}\text{C}$ |
| Input Bias Current                                      | $I_{BIWD}$               | $I_{IN+}$ or $I_{IN-}$ , $V_{CM} = 0\text{V}$                                                    |        |     | 20   | 200          | nA                             |
|                                                         |                          |                                                                                                  |        |     |      | 200          |                                |
| Input Offset Current                                    | $I_{IO}$                 | $I_{IN+} - I_{IN-}$ , $V_{CM} = 0\text{V}$                                                       |        |     | 5    | 30           | nA                             |
|                                                         |                          |                                                                                                  |        |     |      | 100          |                                |
| Input Common Mode Voltage                               | $V_{IR}$                 | $V_{CC} = 30\text{V}$                                                                            |        | 0   |      | $V_{CC}-1.5$ | V                              |
| Supply Current                                          | $I_{CC}$                 | $T_A = -40$ to $85^{\circ}\text{C}$ , $R_L = \infty$ , $V_{CC} = 30\text{V}$                     |        |     | 0.7  | 2            | mA                             |
|                                                         |                          | $T_A = -40$ to $85^{\circ}\text{C}$ , $R_L = \infty$ , $V_{CC} = 5\text{V}$                      |        |     | 0.5  | 1.2          |                                |
| Large Signal Voltage Gain                               | $G_V$                    | $V_{CC} = 15\text{V}$ , $V_O = 1\text{V}$ to $11\text{V}$ , $R_L \geq 2\text{k}\Omega$           |        | 85  | 100  |              | dB                             |
|                                                         |                          |                                                                                                  |        | 80  |      |              |                                |
| Common Mode Rejection Ratio                             | $C_{MRR}$                | DC, $V_{CM} = 0\text{V}$ to $(V_{CC}-1.5)\text{V}$                                               |        | 60  | 70   |              | dB                             |
|                                                         |                          |                                                                                                  |        | 60  |      |              |                                |
| Power Supply Rejection Ratio                            | $P_{SRR}$                | $V_{CC} = 5\text{V}$ to $30\text{V}$                                                             |        | 70  | 100  |              | dB                             |
|                                                         |                          |                                                                                                  |        | 60  |      |              |                                |
| Channel Separation                                      | CS                       | $f=1\text{kHz}$ to $20\text{kHz}$                                                                |        |     | -120 |              | dB                             |
| Output Current                                          | Source                   | $I_{SOURCE}$ , $V_+ = 1\text{V}$ , $V_- = 0\text{V}$ , $V_{CC} = 15\text{V}$ , $V_O = 2\text{V}$ |        | 20  | 40   |              | mA                             |
|                                                         |                          |                                                                                                  |        | 20  |      |              |                                |
|                                                         | Sink                     | $I_{SINK}$ , $V_+ = 0\text{V}$ , $V_- = 1\text{V}$ , $V_{CC} = 15\text{V}$ , $V_O = 2\text{V}$   |        | 10  | 15   |              | mA                             |
|                                                         |                          |                                                                                                  |        | 5   |      |              |                                |
|                                                         |                          | $V_+ = 0\text{V}$ , $V_- = 1\text{V}$ , $V_{CC} = 15\text{V}$ , $V_O = 0.2\text{V}$              |        | 12  | 50   |              | $\mu\text{A}$                  |
|                                                         |                          |                                                                                                  |        |     |      |              |                                |
| Output Short Circuit Current to Ground                  | $I_{SC}$                 | $V_{CC} = 15\text{V}$                                                                            |        |     | 40   | 60           | mA                             |
| Output Voltage Swing                                    | $V_{OH}$                 | $V_{CC} = 30\text{V}$ , $R_L = 2\text{k}$                                                        |        | 26  |      |              | V                              |
|                                                         |                          |                                                                                                  |        | 26  |      |              |                                |
|                                                         |                          | $V_{CC} = 30\text{V}$ , $R_L = 10\text{k}$                                                       |        | 27  | 28   |              |                                |
|                                                         |                          |                                                                                                  |        | 27  |      |              |                                |
|                                                         | $V_{OL}$                 | $V_{CC} = 5\text{V}$ , $R_L = 10\text{k}$                                                        |        |     | 5    | 20           | mV                             |
|                                                         |                          |                                                                                                  |        |     |      | 30           |                                |

Note 2: Limits over the full temperature are guaranteed by design, but not tested in production.

## Typical Performance Characteristics

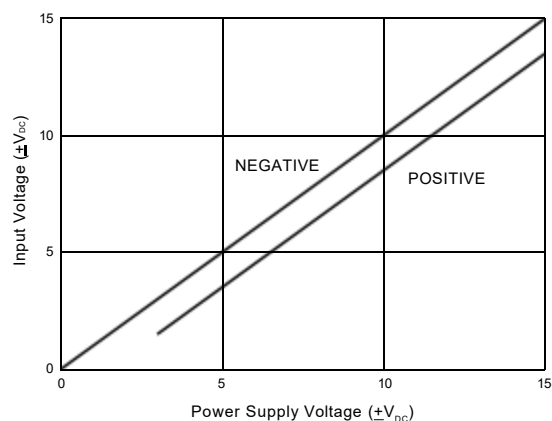


Figure 4. Input Voltage Range

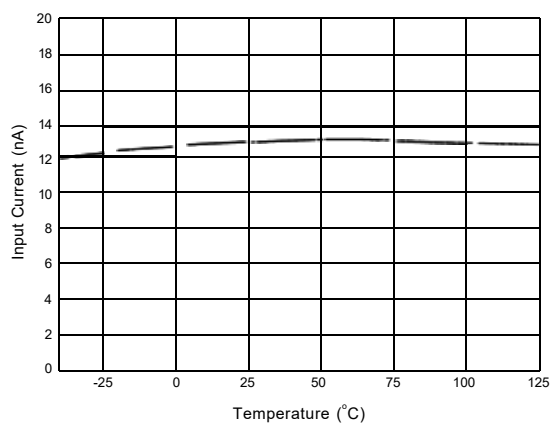


Figure 5. Input Current

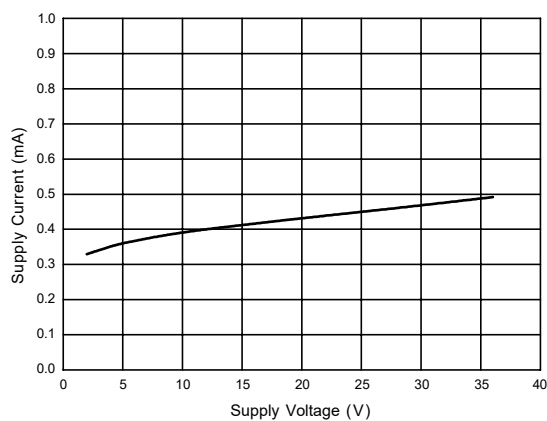


Figure 6. Supply Current

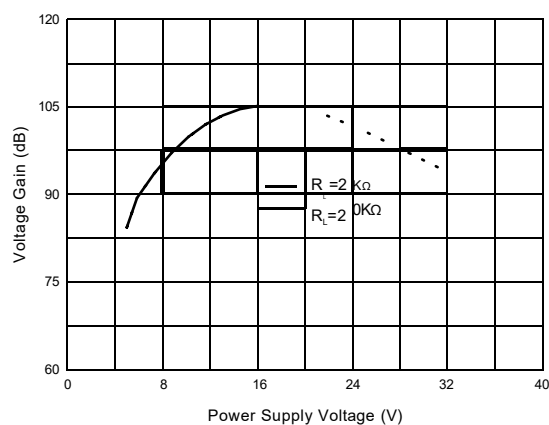


Figure 7. Voltage Gain

## Typical Performance Characteristics (Continued)

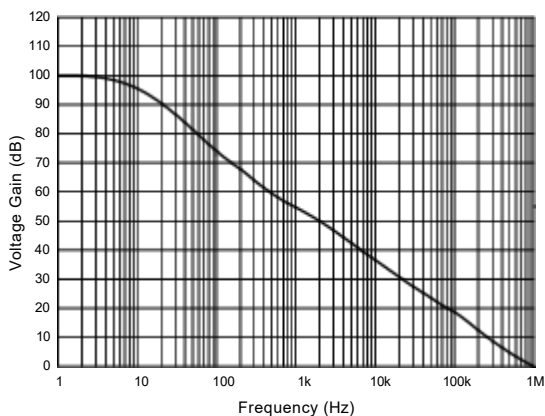


Figure 8. Open Loop Frequency Response

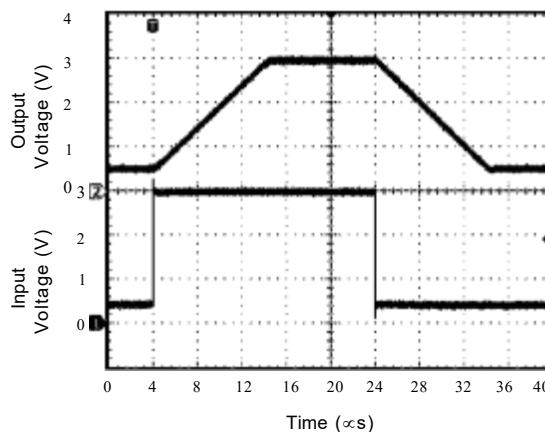


Figure 9. Voltage Follower Pulse Response

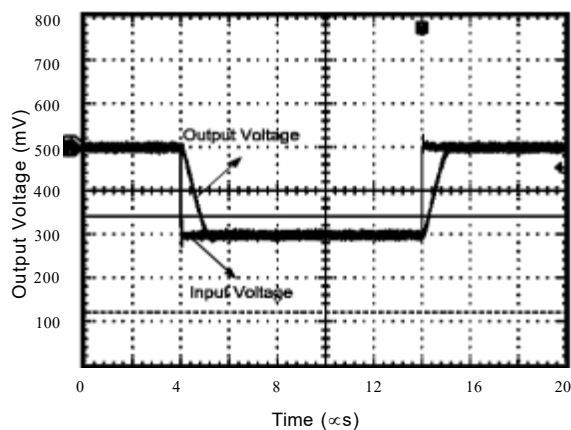


Figure 10. Voltage Follower Pulse Response (Small Signal)

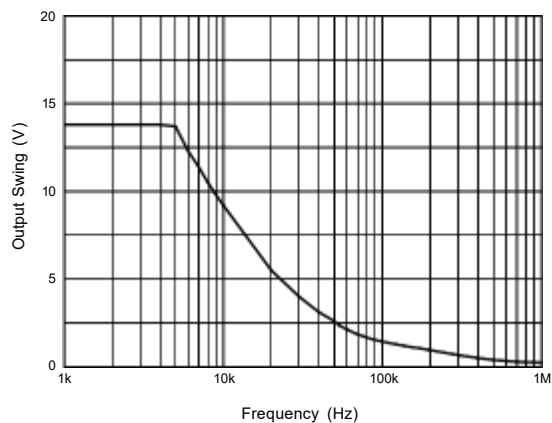


Figure 11. Large Signal Frequency Response

## Typical Performance Characteristics (Continued)

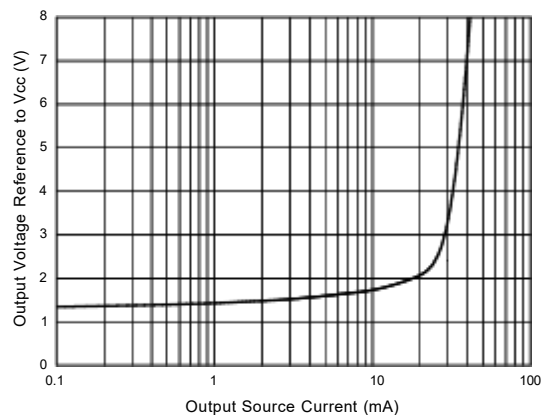


Figure 12. Output Characteristics: Current Sourcing

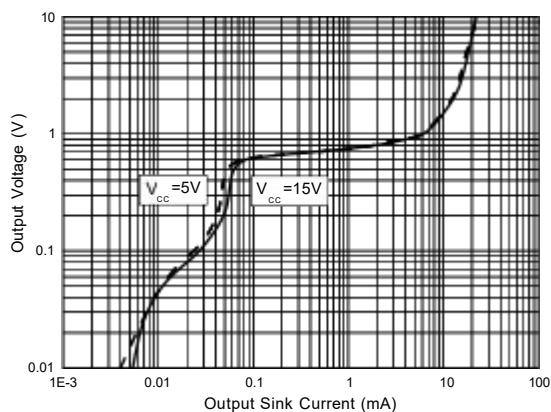


Figure 13. Output Characteristics: Current Sinking

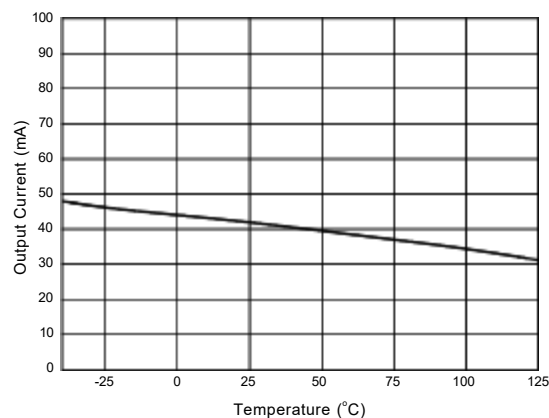


Figure 14. Current Limiting

## Typical Application

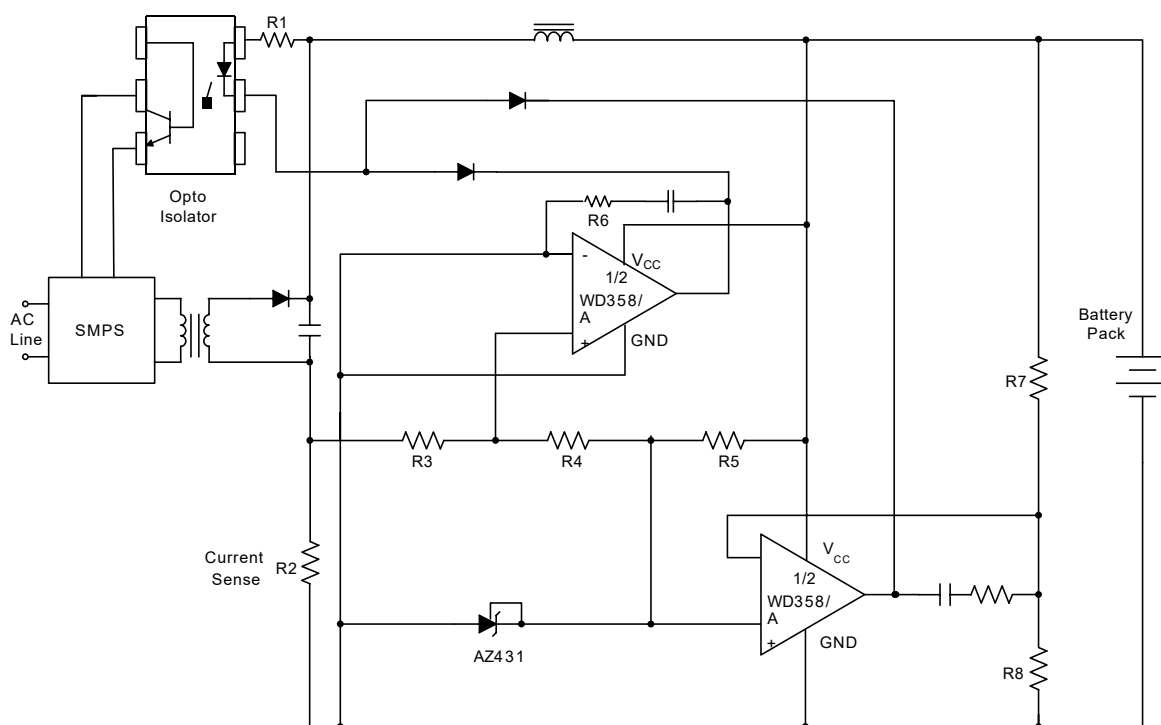


Figure 15. Battery Charger

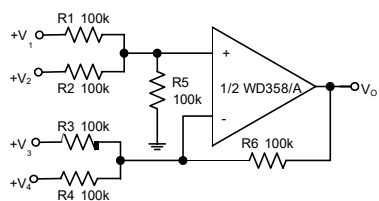


Figure 16. Power Amplifier

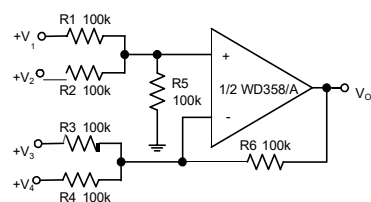


Figure 17. DC Summing Amplifier

## Typical Application (Continued)

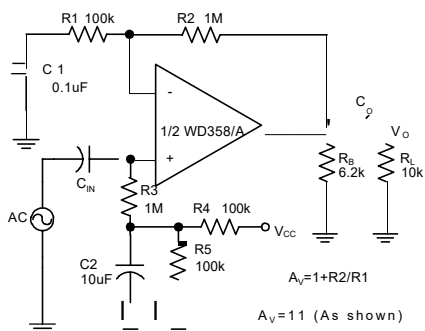


Figure 18. AC Coupled Non-Inverting Amplifier

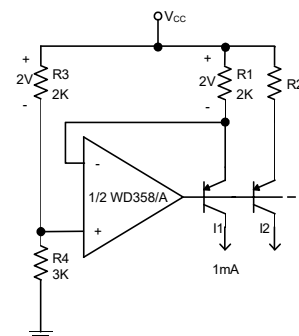


Figure 19. Fixed Current Sources

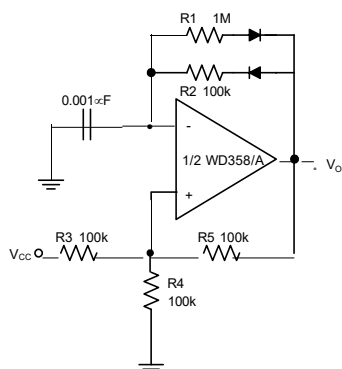


Figure 20. Pulse Generator

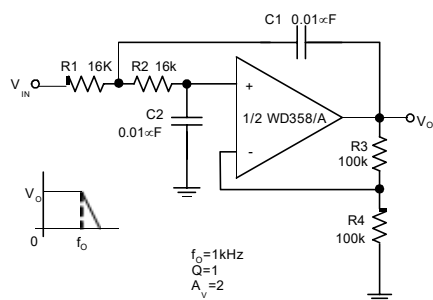
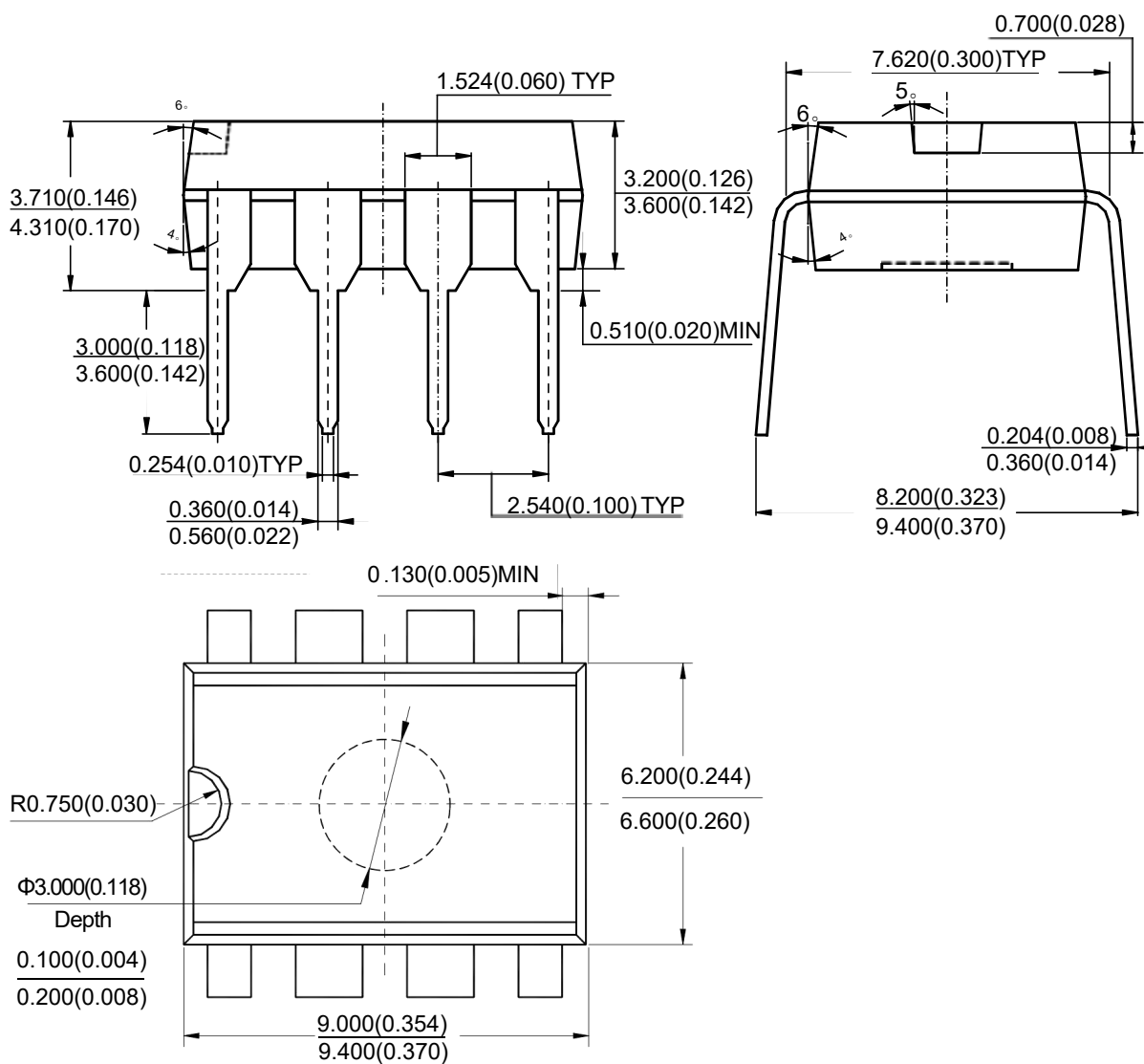


Figure 21. DC Coupled Low-Pass Active Filter

## Mechanical Dimensions

## DIP-8

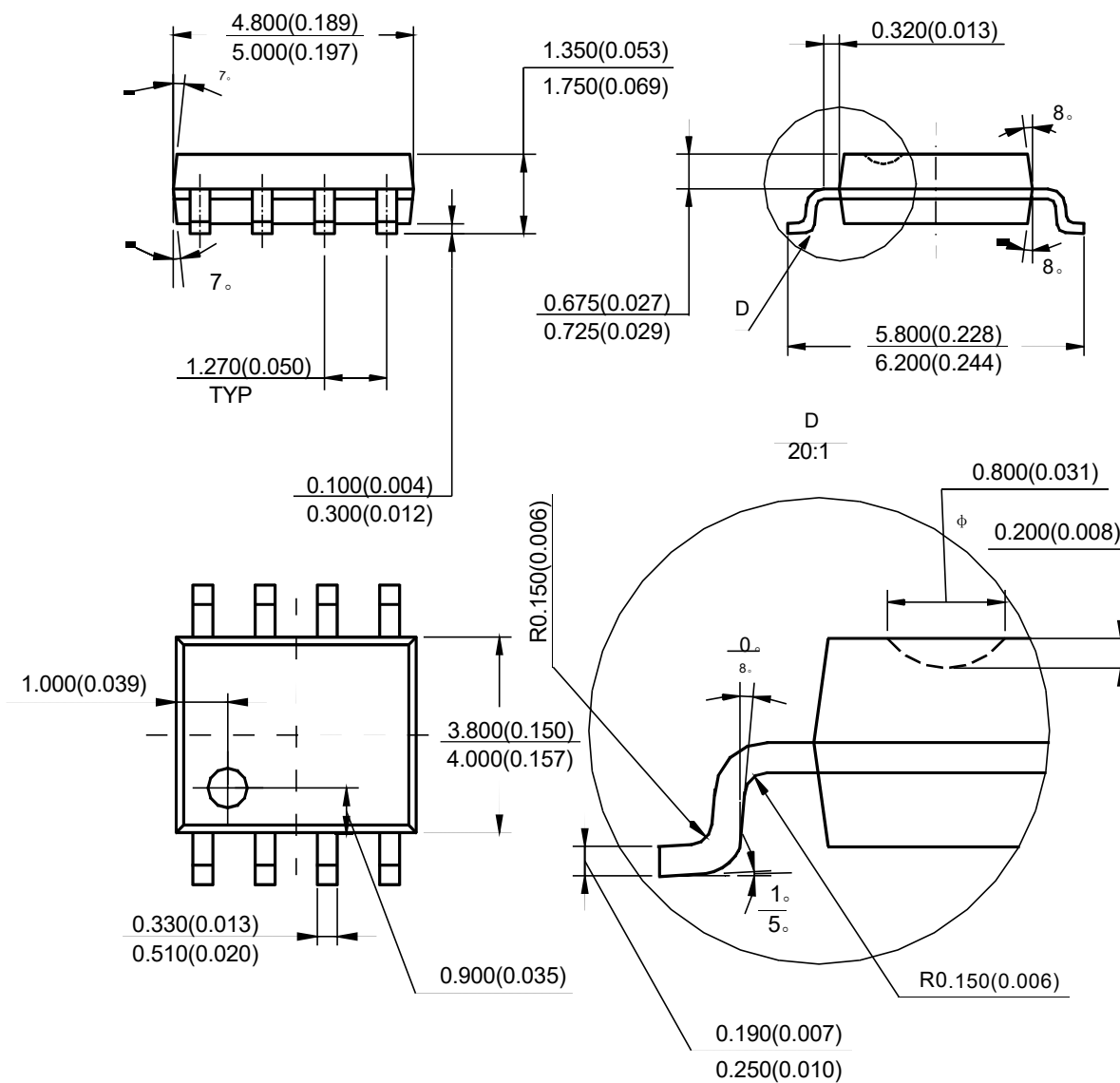
Unit: mm(inch)



## Mechanical Dimensions (Continued)

**SOIC-8**

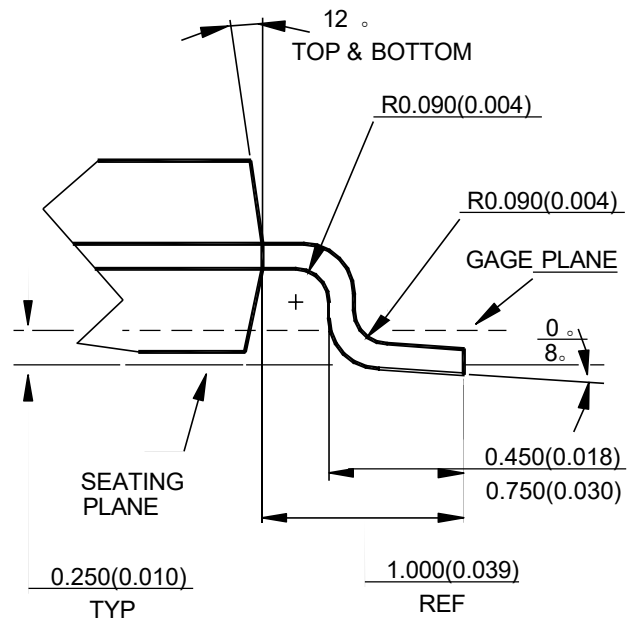
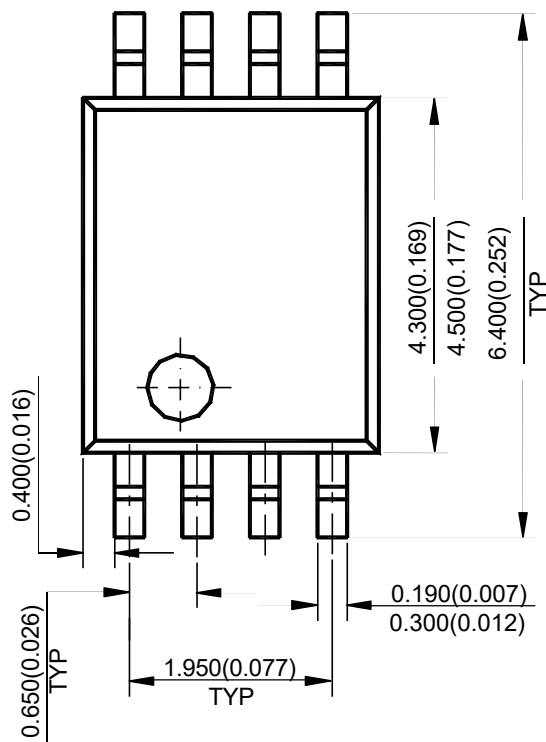
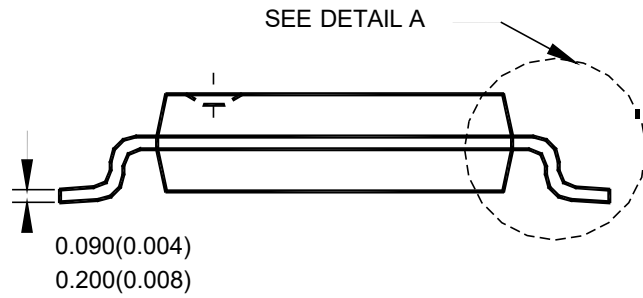
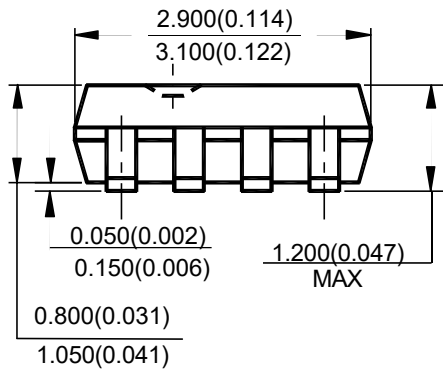
**Unit: mm(inch)**



## Mechanical Dimensions (Continued)

**TSSOP-8**

**Unit: mm(inch)**



DETAIL A