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# LM2904, LM358/LM358A, LM258/ LM258A

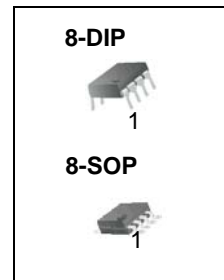
## Dual Operational Amplifier

### Features

- Internally Frequency Compensated for Unity Gain
- Large DC Voltage Gain: 100dB
- Wide Power Supply Range:  
LM258/LM258A, LM358/LM358A: 3V~32V (or  $\pm 1.5V \sim 16V$ )  
LM2904 : 3V~26V (or  $\pm 1.5V \sim 13V$ )
- Input Common Mode Voltage Range Includes Ground
- Large Output Voltage Swing: 0V DC to  $V_{CC} - 1.5V$  DC
- Power Drain Suitable for Battery Operation.

### Description

The LM2904, LM358/LM358A, LM258/LM258A consist of two independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltage. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. Application areas include transducer amplifier, DC gain blocks and all the conventional OP-AMP circuits which now can be easily implemented in single power supply systems.

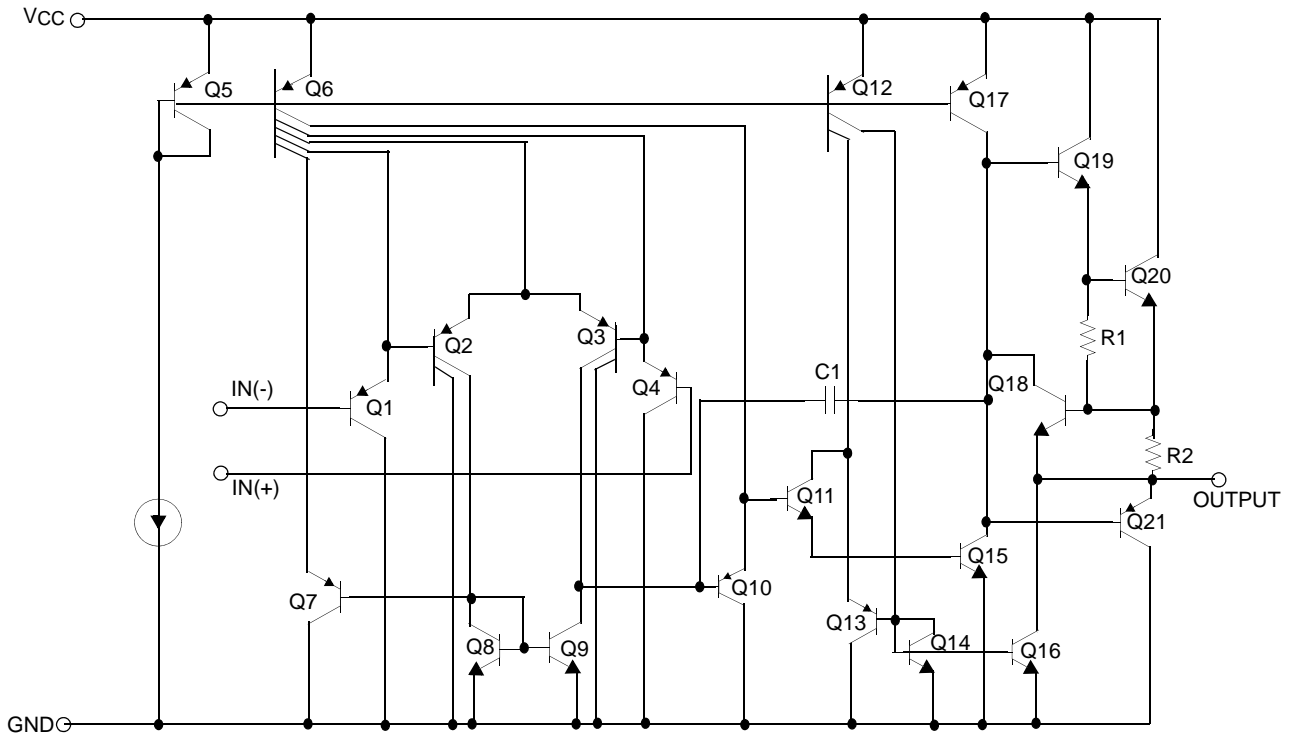


### Internal Block Diagram



## Schematic Diagram

(One section only)



## Absolute Maximum Ratings

| Parameter   | Symbol   | LM258/LM258A | LM358/LM358A | LM2904      | Unit |
|---|----------|--------------|--------------|-------------|------|
| Supply Voltage  | VCC      | ±16 or 32    | ±16 or 32    | ±13 or 26   | V    |
| Differential Input Voltage                                    | VI(DIFF) | 32           | 32           | 26          | V    |
| Input Voltage   | VI       | -0.3 to +32  | -0.3 to +32  | -0.3 to +26 | V    |
| Output Short Circuit to GND<br>VCC ≤ 15V, TA = 25°C (One Amp) | -        | Continuous   | Continuous   | Continuous  | -    |
| Operating Temperature Range                                   | TOPR     | -25 ~ +85    | 0 ~ +70      | -40 ~ +85   | °C   |
| Maximum Junction Temperature                                  | TJ(MAX)  | +150         | +150         | +150        | °C   |
| Storage Temperature Range                                     | TSTG     | -65 ~ +150   | -65 ~ +150   | -65 ~ +150  | °C   |

## Electrical Characteristics

( $V_{CC} = 5.0V$ ,  $V_{EE} = GND$ ,  $T_A = 25^\circ C$ , unless otherwise specified)

| Parameter                    | Symbol        | Conditions  | LM258             |          |                | LM358 |          |                | LM2904 |          |                | Unit    |   |
|------------------------------|---------------|---|-------------------|----------|----------------|-------|----------|----------------|--------|----------|----------------|---------|---|
|                              |               |   | Min.              | Typ.     | Max.           | Min.  | Typ.     | Max.           | Min.   | Typ.     | Max.           |         |   |
| Input Offset Voltage         | $V_{IO}$      | $V_{CM} = 0V$ to $V_{CC} - 1.5V$<br>$V_{O(P)} = 1.4V$ ,<br>$R_S = 0\Omega$    | -                 | 2.9      | 5.0            | -     | 2.9      | 7.0            | -      | 2.9      | 7.0            | mV      |   |
| Input Offset Current         | $I_{IO}$      | -   | -                 | 3        | 30             | -     | 5        | 50             | -      | 5        | 50             | nA      |   |
| Input Bias Current           | $I_{BIAS}$    | -   | -                 | 45       | 150            | -     | 45       | 250            | -      | 45       | 250            | nA      |   |
| Input Voltage Range          | $V_{I(R)}$    | $V_{CC} = 30V$<br>(LM2904, $V_{CC}=26V$ )                                     | 0                 | -        | $V_{CC} - 1.5$ | 0     | -        | $V_{CC} - 1.5$ | 0      | -        | $V_{CC} - 1.5$ | V       |   |
| Supply Current               | $I_{CC}$      | $R_L = \infty$ , $V_{CC} = 30V$<br>(LM2904, $V_{CC}=26V$ )                    | -                 | 0.8      | 2.0            | -     | 0.8      | 2.0            | -      | 0.8      | 2.0            | mA      |   |
|                              |               | $R_L = \infty$ , $V_{CC} = 5V$  | -                 | 0.5      | 1.2            | -     | 0.5      | 1.2            | -      | 0.5      | 1.2            | mA      |   |
| Large Signal Voltage Gain    | $G_V$         | $V_{CC} = 15V$ ,<br>$R_L = 2k\Omega$<br>$V_{O(P)} = 1V$ to $11V$              | 50                | 100      | -              | 25    | 100      | -              | 25     | 100      | -              | V/mV    |   |
| Output Voltage Swing         | $V_{O(H)}$    | $V_{CC}=30V$<br>( $V_{CC} = 26V$ for LM2904)                                  | $R_L = 2k\Omega$  | 26       | -              | -     | 26       | -              | -      | 22       | -              | -       | V |
|                              |               |   | $R_L = 10k\Omega$ | 27       | 28             | -     | 27       | 28             | -      | 23       | 24             | -       | V |
|                              | $V_{O(L)}$    | $V_{CC} = 5V$ , $R_L = 10k\Omega$   | -                 | 5        | 20             | -     | 5        | 20             | -      | 5        | 20             | mV      |   |
| Common-Mode Rejection Ratio  | CMRR          | -   | 70                | 85       | -              | 65    | 80       | -              | 50     | 80       | -              | dB      |   |
| Power Supply Rejection Ratio | PSRR          | -   | 65                | 100      | -              | 65    | 100      | -              | 50     | 100      | -              | dB      |   |
| Channel Separation           | CS            | $f = 1kHz$ to $20kHz$<br>(Note1)  | -                 | 120      | -              | -     | 120      | -              | -      | 120      | -              | dB      |   |
| Short Circuit to GND         | $I_{SC}$      | -   | -                 | 40       | 60             | -     | 40       | 60             | -      | 40       | 60             | mA      |   |
| Output Current               | $I_{SOURCE}$  | $V_{I(+)} = 1V$ ,<br>$V_{I(-)} = 0V$ ,<br>$V_{CC} = 15V$ ,<br>$V_{O(P)} = 2V$ | 20                | 30       | -              | 20    | 30       | -              | 20     | 30       | -              | mA      |   |
|                              |               |   | 10                | 15       | -              | 10    | 15       | -              | 10     | 15       | -              | mA      |   |
|                              | $I_{SINK}$    | $V_{I(+)} = 0V$ , $V_{I(-)} = 1V$ ,<br>$V_{CC} = 15V$ ,<br>$V_{O(P)} = 2V$    | 12                | 100      | -              | 12    | 100      | -              | -      | -        | -              | $\mu A$ |   |
| Differential Input Voltage   | $V_{I(DIFF)}$ | -   | -                 | $V_{CC}$ | -              | -     | $V_{CC}$ | -              | -      | $V_{CC}$ | V              |         |   |

### Note:

1. This parameter, although guaranteed, is not 100% tested in production.

**Electrical Characteristics** (Continued)

(VCC = 5.0V, VEE = GND, unless otherwise specified)

The following specifications apply over the range of  $-25^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$  for the LM258; and the  $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$  for the LM358; and the  $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$  for the LM2904

| Parameter                  | Symbol               | Conditions   | LM258                |      |                       | LM358 |      |                       | LM2904 |      |                       | Unit  |   |
|----------------------------|----------------------|--|----------------------|------|-----------------------|-------|------|-----------------------|--------|------|-----------------------|-------|---|
|                            |                      |  | Min.                 | Typ. | Max.                  | Min.  | Typ. | Max.                  | Min.   | Typ. | Max.                  |       |   |
| Input Offset Voltage       | V <sub>IO</sub>      | V <sub>CM</sub> = 0V to V <sub>CC</sub> - 1.5V<br>V <sub>O(P)</sub> = 1.4V,<br>R <sub>S</sub> = 0Ω     | -                    | -    | 7.0                   | -     | -    | 9.0                   | -      | -    | 10.0                  | mV    |   |
| Input Offset Voltage Drift | ΔV <sub>IO</sub> /ΔT | R <sub>S</sub> = 0Ω  | -                    | 7.0  | -                     | -     | 7.0  | -                     | -      | 7.0  | -                     | μV/°C |   |
| Input Offset Current       | I <sub>IO</sub>      | -  | -                    | -    | 100                   | -     | -    | 150                   | -      | 45   | 200                   | nA    |   |
| Input Offset Current Drift | ΔI <sub>IO</sub> /ΔT | -  | -                    | 10   | -                     | -     | 10   | -                     | -      | 10   | -                     | pA/°C |   |
| Input Bias Current         | I <sub>BIAS</sub>    | -  | -                    | 40   | 300                   | -     | 40   | 500                   | -      | 40   | 500                   | nA    |   |
| Input Voltage Range        | V <sub>I(R)</sub>    | V <sub>CC</sub> = 30V (LM2904, V <sub>CC</sub> = 26V)  | 0                    | -    | V <sub>CC</sub> - 2.0 | 0     | -    | V <sub>CC</sub> - 2.0 | 0      | -    | V <sub>CC</sub> - 2.0 | V     |   |
| Large Signal Voltage Gain  | G <sub>V</sub>       | V <sub>CC</sub> = 15V,<br>R <sub>L</sub> = 2.0kΩ<br>V <sub>O(P)</sub> = 1V to 11V                      | 25                   | -    | -                     | 15    | -    | -                     | 15     | -    | -                     | V/mV  |   |
| Output Voltage Swing       | V <sub>O(H)</sub>    | V <sub>CC</sub> = 30V (V <sub>CC</sub> = 26V for LM2904)   | R <sub>L</sub> = 2kΩ | 26   | -                     | -     | 26   | -                     | -      | 22   | -                     | -     | V |
|                            |                      | R <sub>L</sub> = 10kΩ  | 27                   | 28   | -                     | 27    | 28   | -                     | 23     | 24   | -                     | V     |   |
|                            | V <sub>O(L)</sub>    | V <sub>CC</sub> = 5V, R <sub>L</sub> = 10kΩ  | -                    | 5    | 20                    | -     | 5    | 20                    | -      | 5    | 20                    | mV    |   |
| Output Current             | I <sub>SOURCE</sub>  | V <sub>I(+)</sub> = 1V,<br>V <sub>I(-)</sub> = 0V,<br>V <sub>CC</sub> = 15V,<br>V <sub>O(P)</sub> = 2V | 10                   | 30   | -                     | 10    | 30   | -                     | 10     | 30   | -                     | mA    |   |
|                            | I <sub>SINK</sub>    | V <sub>I(+)</sub> = 0V,<br>V <sub>I(-)</sub> = 1V,<br>V <sub>CC</sub> = 15V,<br>V <sub>O(P)</sub> = 2V | 5                    | 8    | -                     | 5     | 9    | -                     | 5      | 9    | -                     | mA    |   |
| Differential Input Voltage | V <sub>I(DIFF)</sub> | -  | -                    | -    | V <sub>CC</sub>       | -     | -    | V <sub>CC</sub>       | -      | -    | V <sub>CC</sub>       | V     |   |

**Electrical Characteristics** (Continued)

(VCC = 5.0V, VEE = GND, TA = 25°C, unless otherwise specified)

| Parameter                    | Symbol               | Conditions  | LM258A                |      |                         | LM358A |      |                         | Unit |
|------------------------------|----------------------|---|-----------------------|------|-------------------------|--------|------|-------------------------|------|
|                              |                      |   | Min.                  | Typ. | Max.                    | Min.   | Typ. | Max.                    |      |
| Input Offset Voltage         | V <sub>IO</sub>      | V <sub>CM</sub> = 0V to V <sub>CC</sub> -1.5V<br>V <sub>O(P)</sub> = 1.4V, R <sub>S</sub> = 0Ω  | -                     | 1.0  | 3.0                     | -      | 2.0  | 3.0                     | mV   |
| Input Offset Current         | I <sub>IO</sub>      | -   | -                     | 2    | 15                      | -      | 5    | 30                      | nA   |
| Input Bias Current           | I <sub>BIAS</sub>    | -   | -                     | 40   | 80                      | -      | 45   | 100                     | nA   |
| Input Voltage Range          | V <sub>I(R)</sub>    | V <sub>CC</sub> = 30V   | 0                     | -    | V <sub>CC</sub><br>-1.5 | 0      | -    | V <sub>CC</sub><br>-1.5 | V    |
| Supply Current               | I <sub>CC</sub>      | R <sub>L</sub> = ∞, V <sub>CC</sub> = 30V   | -                     | 0.8  | 2.0                     | -      | 0.8  | 2.0                     | mA   |
|                              |                      | R <sub>L</sub> = ∞, V <sub>CC</sub> = 5V  | -                     | 0.5  | 1.2                     | -      | 0.5  | 1.2                     | mA   |
| Large Signal Voltage Gain    | G <sub>V</sub>       | V <sub>CC</sub> = 15V, R <sub>L</sub> = 2kΩ<br>V <sub>O</sub> = 1V to 11V                       | 50                    | 100  | -                       | 25     | 100  | -                       | V/mV |
| Output Voltage Swing         | V <sub>OH</sub>      | V <sub>CC</sub> = 30V   | R <sub>L</sub> = 2kΩ  | 26   | -                       | -      | 26   | -                       | V    |
|                              |                      |   | R <sub>L</sub> = 10kΩ | 27   | 28                      | -      | 27   | 28                      | -    |
|                              | V <sub>OL</sub>      | V <sub>CC</sub> = 5V, R <sub>L</sub> = 10kΩ   | -                     | 5    | 20                      | -      | 5    | 20                      | mV   |
| Common-Mode Rejection Ratio  | CMRR                 | -   | 70                    | 85   | -                       | 65     | 85   | -                       | dB   |
| Power Supply Rejection Ratio | PSRR                 | -   | 65                    | 100  | -                       | 65     | 100  | -                       | dB   |
| Channel Separation           | CS                   | f = 1kHz to 20kHz (Note1)   | -                     | 120  | -                       | -      | 120  | -                       | dB   |
| Short Circuit to GND         | I <sub>SC</sub>      | -   | -                     | 40   | 60                      | -      | 40   | 60                      | mA   |
| Output Current               | I <sub>SOURCE</sub>  | V <sub>I(+)</sub> = 1V, V <sub>I(-)</sub> = 0V<br>V <sub>CC</sub> = 15V, V <sub>O(P)</sub> = 2V | 20                    | 30   | -                       | 20     | 30   | -                       | mA   |
|                              | I <sub>SINK</sub>    | V <sub>I(+)</sub> = 1V, V <sub>I(-)</sub> = 0V<br>V <sub>CC</sub> = 15V, V <sub>O(P)</sub> = 2V | 10                    | 15   | -                       | 10     | 15   | -                       | mA   |
|                              |                      | V <sub>in +</sub> = 0V, V <sub>in (-)</sub> = 1V<br>V <sub>O(P)</sub> = 200mV                   | 12                    | 100  | -                       | 12     | 100  | -                       | μA   |
| Differential Input Voltage   | V <sub>I(DIFF)</sub> | -   | -                     | -    | V <sub>CC</sub>         | -      | -    | V <sub>CC</sub>         | V    |

**Note:**

1. This parameter, although guaranteed, is not 100% tested in production.

**Electrical Characteristics** (Continued)(V<sub>CC</sub> = 5.0V, V<sub>EE</sub> = GND, unless otherwise specified)The following specification apply over the range of -25°C ≤ T<sub>A</sub> ≤ +85°C for the LM258A; and the 0°C ≤ T<sub>A</sub> ≤ +70°C for the LM358A

| Parameter                       | Symbol               | Conditions  | LM258A                |      |                         | LM358A |      |                         | Unit  |   |
|---------------------------------|----------------------|---|-----------------------|------|-------------------------|--------|------|-------------------------|-------|---|
|                                 |                      |   | Min.                  | Typ. | Max.                    | Min.   | Typ. | Max.                    |       |   |
| Input Offset Voltage            | V <sub>IO</sub>      | V <sub>CM</sub> = 0V to V <sub>CC</sub> -1.5V<br>V <sub>O(P)</sub> = 1.4V, R <sub>S</sub> = 0Ω  | -                     | -    | 4.0                     | -      | -    | 5.0                     | mV    |   |
| Input Offset Voltage Drift      | ΔV <sub>IO</sub> /ΔT | -   | -                     | 7.0  | 15                      | -      | 7.0  | 20                      | μV/°C |   |
| Input Offset Current            | I <sub>IO</sub>      | -   | -                     | -    | 30                      | -      | -    | 75                      | nA    |   |
| Input Offset Current Drift      | ΔI <sub>IO</sub> /ΔT | -   | -                     | 10   | 200                     | -      | 10   | 300                     | pA/°C |   |
| Input Bias Current              | I <sub>BIAS</sub>    | -   | -                     | 40   | 100                     | -      | 40   | 200                     | nA    |   |
| Input Common-Mode Voltage Range | V <sub>I(R)</sub>    | V <sub>CC</sub> = 30V   | 0                     | -    | V <sub>CC</sub><br>-2.0 | 0      | -    | V <sub>CC</sub><br>-2.0 | V     |   |
| Output Voltage Swing            | V <sub>O(H)</sub>    | V <sub>CC</sub> = 30V   | R <sub>L</sub> = 2kΩ  | 26   | -                       | -      | 26   | -                       | -     | V |
|                                 |                      |   | R <sub>L</sub> = 10kΩ | 27   | 28                      | -      | 27   | 28                      | -     | V |
|                                 | V <sub>O(L)</sub>    | V <sub>CC</sub> = 5V, R <sub>L</sub> =10kΩ  | -                     | 5    | 20                      | -      | 5    | 20                      | mV    |   |
| Large Signal Voltage Gain       | G <sub>V</sub>       | V <sub>CC</sub> = 15V, R <sub>L</sub> =2.0kΩ<br>V <sub>O(P)</sub> = 1V to 11V                   | 25                    | -    | -                       | 15     | -    | -                       | V/mV  |   |
| Output Current                  | I <sub>SOURCE</sub>  | V <sub>I(+)</sub> = 1V, V <sub>I(-)</sub> = 0V<br>V <sub>CC</sub> = 15V, V <sub>O(P)</sub> = 2V | 10                    | 30   | -                       | 10     | 30   | -                       | mA    |   |
|                                 | I <sub>SINK</sub>    | V <sub>I(+)</sub> = 1V, V <sub>I(-)</sub> = 0V<br>V <sub>CC</sub> = 15V, V <sub>O(P)</sub> = 2V | 5                     | 9    | -                       | 5      | 9    | -                       | mA    |   |
| Differential Input Voltage      | V <sub>I(DIFF)</sub> | -   | -                     | -    | V <sub>CC</sub>         | -      | -    | V <sub>CC</sub>         | V     |   |

# Typical Performance Characteristics



Figure 1. Supply Current vs Supply Voltage

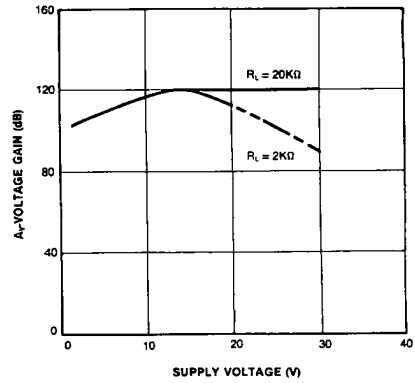


Figure 2. Voltage Gain vs Supply Voltage

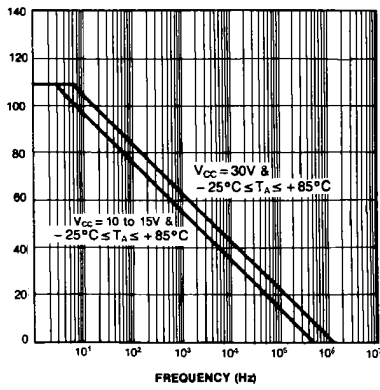


Figure 3. Open Loop Frequency Response

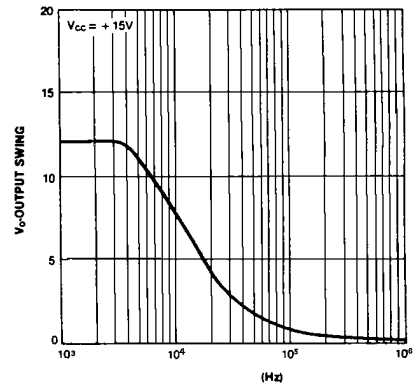


Figure 4. Large Signal Output Swing vs Frequency

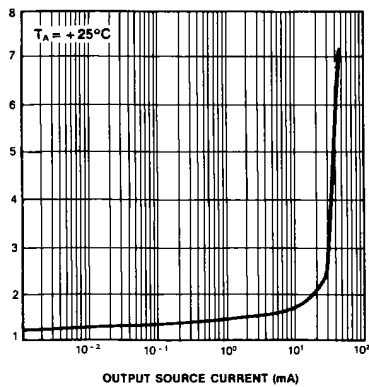


Figure 5. Output Characteristics vs Current Sourcing



Figure 6. Output Characteristics vs Current Sinking



Typical Performance Characteristics (Continued)



Figure 7. Input Voltage Range vs Supply Voltage



Figure 8. Common-Mode Rejection Ratio



Figure 9. Output Current vs Temperature (Current Limiting)

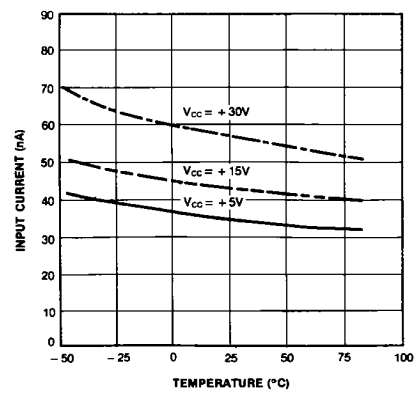


Figure 10. Input Current vs Temperature



Figure 11. Voltage Follower Pulse Response

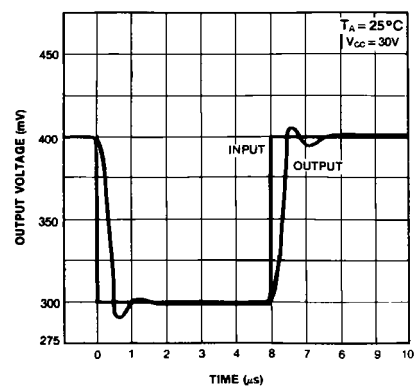


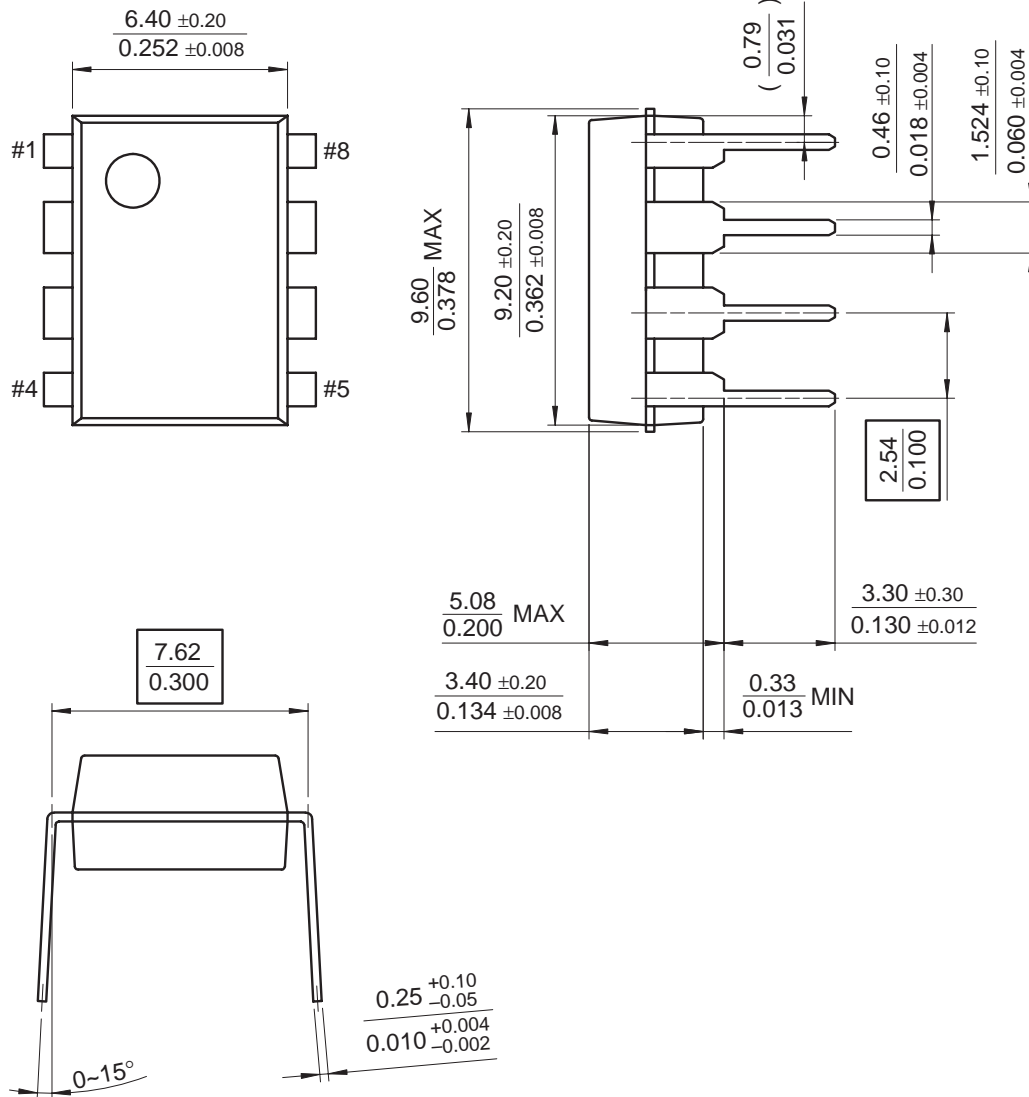
Figure 12. Voltage Follower Pulse Response (Small Signal)

# Mechanical Dimensions

## Package

Dimensions in millimeters

### 8-DIP

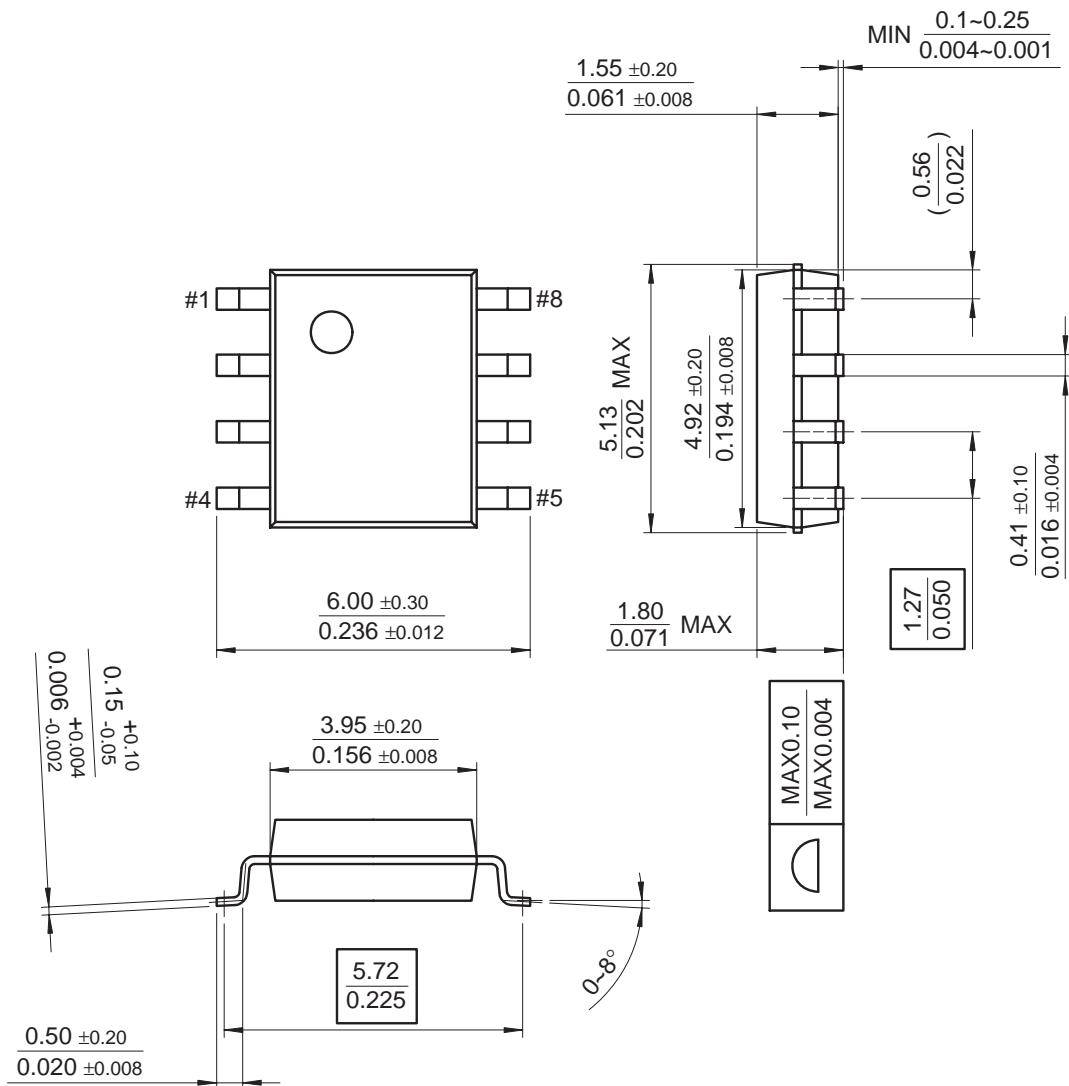


# Mechanical Dimensions (Continued)

## Package

Dimensions in millimeters

### 8-SOP



## Ordering Information

| Product Number | Package | Operating Temperature |
|----------------|---------|-----------------------|
| LM358N         | 8-DIP   | 0 ~ +70°C             |
| LM358AN        |         |                       |
| LM358M         | 8-SOP   |                       |
| LM358AM        |         |                       |
| LM2904N        | 8-DIP   | -40 ~ +85°C           |
| LM2904M        | 8-SOP   |                       |
| LM258N         | 8-DIP   | -25 ~ +85°C           |
| LM258AN        |         |                       |
| LM258M         | 8-SOP   |                       |
| LM258AM        |         |                       |

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