# KA258/KA258A, KA358/KA358A, KA2904

## Dual Operational Amplifier

### Features

- Internally Frequency Compensated for Unity Gain
- Large DC Voltage Gain: 100dB
- Wide Power Supply Range:
  KA258/KA258A, KA358/KA358A: 3V ~ 32V (or ±1.5V~ 16V)
  KA2904 : 3V~26V (or ±1.5V ~ 13V)
- Input Common Mode Voltage Range Includes Ground
- Large Output Voltage Swing: 0V DC to Vcc - 1.5V DC
- Power Drain Suitable for Battery Operation.

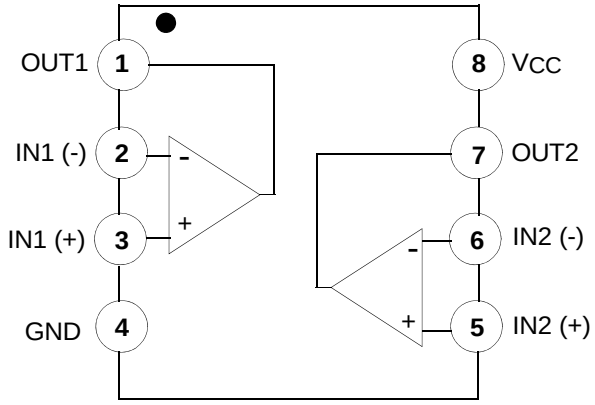
### Description

The KA258 series 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.

**8-DIP**

**8-SOIC**

### Internal Block Diagram



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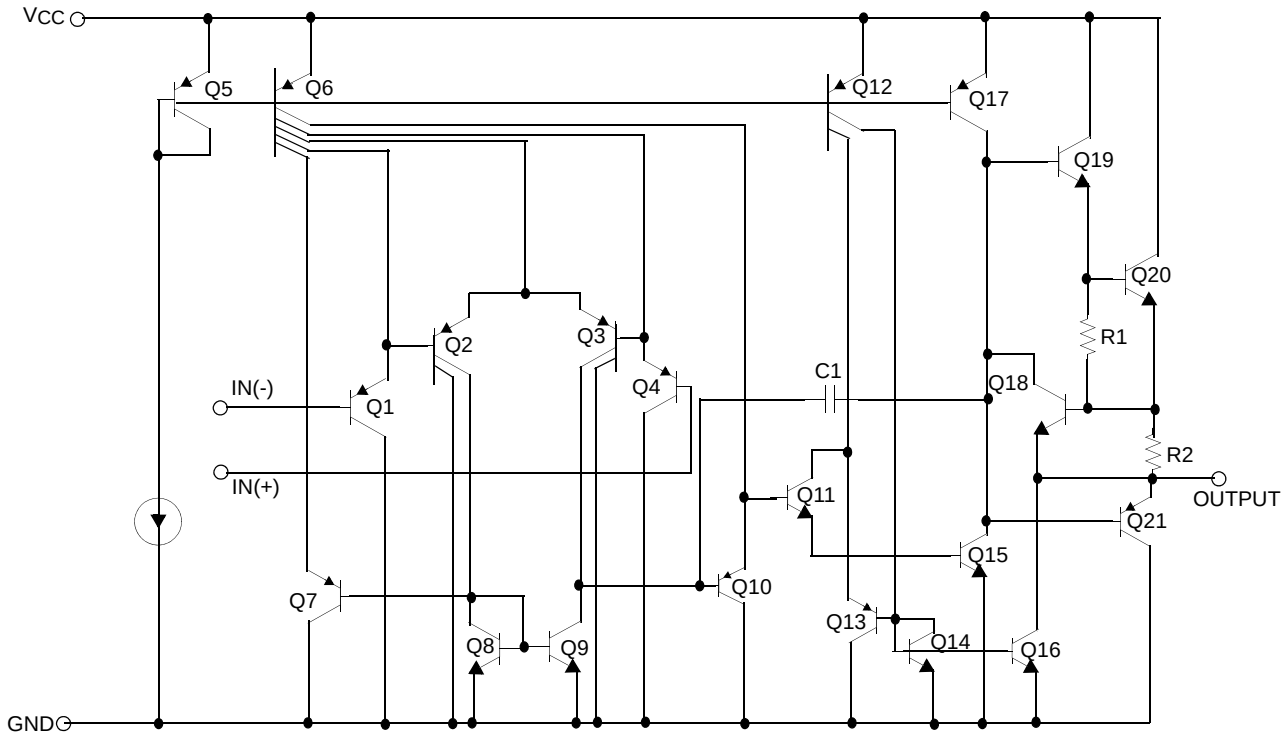
## Schematic Diagram

(One section only)




## Absolute Maximum Ratings

| Parameter | Symbol | KA258/KA258A | KA358/KA358A | KA2904 | Unit |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | ±16 or 32 | ±16 or 32 | ±13 or 26 | V |
| Differential Input Voltage | $V_{I(DIFF)}$ | 32 | 32 | 26 | V |
| Input Voltage | $V_I$ | -0.3 to +32 | -0.3 to +32 | -0.3 to +26 | V |
| Output Short Circuit to GND $V_{CC}$≤15V, $T_A$ = 25°C(One Amp) | - | Continuous | Continuous | Continuous | - |
| Operating Temperature Range | $T_{OPR}$ | -25 ~ +85 | 0 ~ +70 | -40 ~ +85 | °C |
| Maximum Junction Temperature | $T_{J(MAX)}$ | +150 | +150 | +150 | °C |
| Storage Temperature Range | $T_{STG}$ | -65 ~ +150 | -65 ~ +150 | -65 ~ +150 | °C |

## Electrical Characteristics

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

| Parameter | Symbol | Conditions | KA258 | | | KA358 | | | KA2904 | | | 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, $R_S$ = 0Ω | - | 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>(KA2904, $V_{CC}$ = 26V) | 0 | - | $V_{CC}$ -1.5 | 0 | - | $V_{CC}$ -1.5 | 0 | - | $V_{CC}$ -1.5 | V |
| Supply Current | $I_{CC}$ | $R_L$ = ∞, $V_{CC}$ = 30V<br>(KA2904, $V_{CC}$ = 26V) | - | 0.8 | 2.0 | - | 0.8 | 2.0 | - | 0.8 | 2.0 | mA |
| | | $R_L$ = ∞, $V_{CC}$ = 5V | - | 0.5 | 1.2 | - | 0.5 | 1.2 | - | 0.5 | 1.2 | mA |
| Large Signal Voltage Gain | $G_V$ | $V_{CC}$ = 15V, $R_L$ = 2kΩ<br>$V_{O(P)}$ = 1V to 11V | 50 | 100 | - | 25 | 100 | - | 25 | 100 | - | V/mV |
| Output Voltage Swing | $V_{O(H)}$ | $V_{CC}$ = 30V ($V_{CC}$ = 26V for KA2904), $R_L$ = 2kΩ | 26 | - | - | 26 | - | - | 22 | - | - | V |
| | | $V_{CC}$ = 30V ($V_{CC}$ = 26V for KA2904), $R_L$ = 10kΩ | 27 | 28 | - | 27 | 28 | - | 23 | 24 | - | V |
| | $V_{O(L)}$ | $V_{CC}$ = 5V, $R_L$ = 10kΩ | - | 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, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | 20 | 30 | - | 20 | 30 | - | 20 | 30 | - | mA |
| | $I_{SINK}$ | $V_{I(+)}$ = 0V, $V_{I(-)}$ = 1V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | 10 | 15 | - | 10 | 15 | - | 10 | 15 | - | mA |
| | | $V_{I(+)}$ = 0V, $V_{I(-)}$ = 1V<br>$V_{CC}$ = 15V,<br>$V_{O(P)}$ = 200mV | 12 | 100 | - | 12 | 100 | - | - | - | - | μA |
| 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)

($V_{CC}$ = 5.0V, $V_{EE}$ = GND, unless otherwise specified)
The following specification apply over the range of -25°C ≤ $T_A$ ≤ +85°C for the KA258; and the 0 °C ≤ $T_A$ ≤ +70°C for the KA358; and the -40°C ≤ $T_A$ ≤ +85°C for the KA2904

| Parameter | Symbol | Conditions | KA258 | | | KA358 | | | KA2904 | | | 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, $R_S$ = 0Ω | - | - | 7.0 | - | - | 9.0 | - | - | 10.0 | mV |
| Input Offset Voltage Drift | $\Delta V_{IO}/\Delta T$ | $R_S$ = 0Ω | - | 7.0 | - | - | 7.0 | - | - | 7.0 | - | μV/°C |
| Input Offset Current | $I_{IO}$ | - | - | - | 100 | - | - | 150 | - | 45 | 200 | nA |
| Input Offset Current Drift | $\Delta I_{IO}/\Delta T$ | - | - | 10 | - | - | 10 | - | - | 10 | - | pA/°C |
| Input Bias Current | $I_{BIAS}$ | - | - | 40 | 300 | - | 40 | 500 | - | 40 | 500 | nA |
| Input Voltage Range | $V_{I(R)}$ | $V_{CC}$ = 30V<br>(KA2904,$V_{CC}$ = 26V) | 0 | - | $V_{CC}$ -2.0 | 0 | - | $V_{CC}$ -2.0 | 0 | - | $V_{CC}$ -2.0 | V |
| Large Signal Voltage Gain | $G_V$ | $V_{CC}$ = 15V, $R_L$=2.0kΩ<br>$V_{O(P)}$ = 1V to 11V | 25 | - | - | 15 | - | - | 15 | - | - | V/mV |
| Output Voltage Swing | $V_{O(H)}$ | $V_{CC}$ = 30V ($V_{CC}$ = 26V for KA2904), $R_L$ = 2kΩ | 26 | - | - | 26 | - | - | 22 | - | - | V |
| | | $V_{CC}$ = 30V ($V_{CC}$ = 26V for KA2904), $R_L$ = 10kΩ | 27 | 28 | - | 27 | 28 | - | 23 | 24 | - | V |
| | $V_{O(L)}$ | $V_{CC}$ = 5V, $R_L$=10kΩ | - | 5 | 20 | - | 5 | 20 | - | 5 | 20 | mV |
| Output Current | $I_{SOURCE}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | 10 | 30 | - | 10 | 30 | - | 10 | 30 | - | mA |
| | $I_{SINK}$ | $V_{I(+)}$ = 0V, $V_{I(-)}$ = 1V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | 5 | 8 | - | 5 | 9 | - | 5 | 9 | - | mA |
| Differential Input Voltage | $V_{I(DIFF)}$ | - | - | - | $V_{CC}$ | - | - | $V_{CC}$ | - | - | $V_{CC}$ | V |

## Electrical Characteristics (Continued)

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

| Parameter | Symbol | Conditions | | KA258A | | | KA358A | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 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, $R_S$ = 0Ω | | - | 1.0 | 3.0 | - | 2.0 | 3.0 | mV |
| Input Offset Current | $I_{IO}$ | - | | - | 2 | 15 | - | 5 | 30 | nA |
| Input Bias Current | $I_{BIAS}$ | - | | - | 40 | 80 | - | 45 | 100 | nA |
| Input Voltage Range | $V_{I(R)}$ | $V_{CC}$ = 30V | | 0 | - | $V_{CC}$ -1.5 | 0 | - | $V_{CC}$ -1.5 | V |
| Supply Current | $I_{CC}$ | $R_L$ = ∞,$V_{CC}$ = 30V | | - | 0.8 | 2.0 | - | 0.8 | 2.0 | mA |
| | | RL = ∞, $V_{CC}$ = 5V | | - | 0.5 | 1.2 | - | 0.5 | 1.2 | mA |
| Large Signal Voltage Gain | $G_V$ | $V_{CC}$ = 15V, $R_L$=2kΩ<br>$V_O$ = 1V to 11V | | 50 | 100 | - | 25 | 100 | - | V/mV |
| Output Voltage Swing | $V_{OH}$ | $V_{CC}$ = 30V | $R_L$ = 2kΩ | 26 | - | - | 26 | | - | V |
| | | | $R_L$ = 10kΩ | 27 | 28 | - | 27 | 28 | - | V |
| | $V_{O(L)}$ | $V_{CC}$ = 5V, $R_L$=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 | $I_{SC}$ | - | | - | 40 | 60 | - | 40 | 60 | mA |
| Output Current | $I_{SOURCE}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | | 20 | 30 | - | 20 | 30 | - | mA |
| | $I_{SINK}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | | 10 | 15 | - | 10 | 15 | - | mA |
| | | $V_{in(+)}$ = 0V, $V_{in\ (-)}$ = 1V<br>$V_{O(P)}$ = 200mV | | 12 | 100 | - | 12 | 100 | - | μA |
| Differential Input Voltage | $V_{I(DIFF)}$ | - | | - | - | $V_{CC}$ | - | - | $V_{CC}$ | V |

**Note:**

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

## Electrical Characteristics (Continued)

($V_{CC}$ = 5.0V, $V_{EE}$ = GND, unless otherwise specified)
The following specification apply over the range of -25°C ≤ $T_A$ ≤ +85°C for the KA258A; and the 0°C ≤ $T_A$ ≤ +70°C for the KA358A

| Parameter | Symbol | Conditions | | KA258A | | | KA358A | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 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, $R_S$ = 0Ω | | - | - | 4.0 | - | - | 5.0 | mV |
| Input Offset Voltage Drift | $\Delta V_{IO}/\Delta T$ | - | | - | 7.0 | 15 | - | 7.0 | 20 | μV/°C |
| Input Offset Current | $I_{IO}$ | - | | - | - | 30 | - | - | 75 | nA |
| Input Offset Current Drift | $\Delta I_{IO}/\Delta T$ | - | | - | 10 | 200 | - | 10 | 300 | pA/°C |
| Input Bias Current | $I_{BIAS}$ | - | | - | 40 | 100 | - | 40 | 200 | nA |
| Input Common-Mode Voltage Range | $V_{I(R)}$ | $V_{CC}$ = 30V | | 0 | - | $V_{CC}$ -2.0 | 0 | - | $V_{CC}$ -2.0 | V |
| Output Voltage Swing | $V_{O(H)}$ | $V_{CC}$ = 30V | $R_L$ = 2kΩ | 26 | - | - | 26 | - | - | V |
| | | | $R_L$ = 10kΩ | 27 | 28 | - | 27 | 28 | - | V |
| | $V_{O(L)}$ | $V_{CC}$ = 5V, $R_L$=10kΩ | | - | 5 | 20 | - | 5 | 20 | mV |
| Large Signal Voltage Gain | $G_V$ | $V_{CC}$ = 15V, $R_L$=2.0kΩ<br>$V_{O(P)}$ = 1V to 11V | | 25 | - | - | 15 | - | - | V/mV |
| Output Current | $I_{SOURCE}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | | 10 | 30 | - | 10 | 30 | - | mA |
| | $I_{SINK}$ | $V_{I(+)}$ = 1V, $V_{I(-)}$ = 0V<br>$V_{CC}$ = 15V, $V_{O(P)}$ = 2V | | 5 | 9 | - | 5 | 9 | - | mA |
| Differential Input Voltage | $V_{I(DIFF)}$ | - | | - | - | $V_{CC}$ | - | - | $V_{CC}$ | V |

# Typical Performance Characteristics

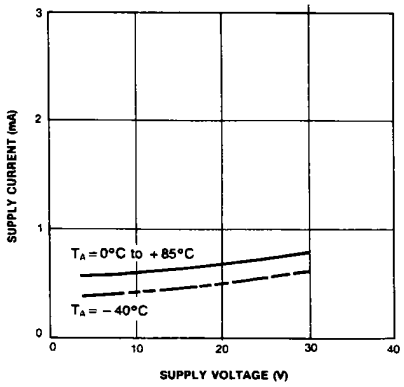



**Figure 1. Supply Current vs Supply Voltage**

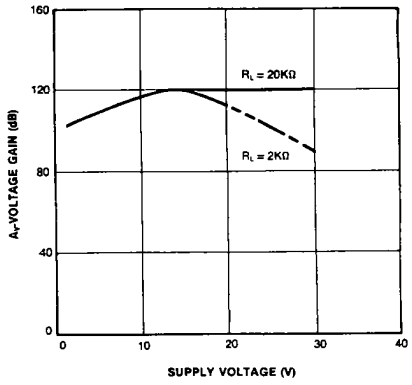



**Figure 2. Voltage Gain vs Supply Voltage**

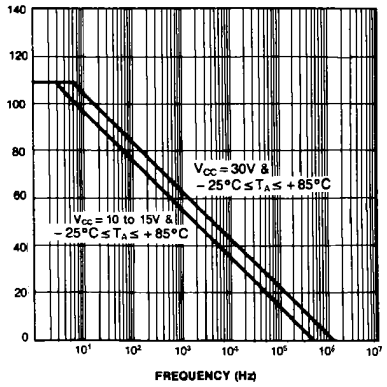



**Figure 3. Open Loop Frequency Response**

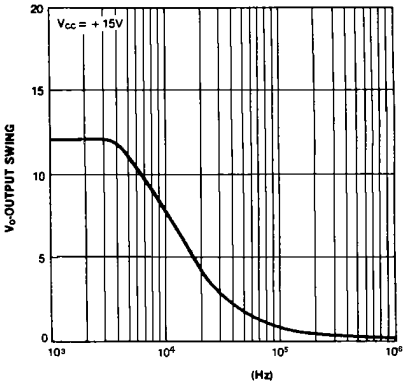



**Figure 4. Large Signal Output Swing vs Frequency**

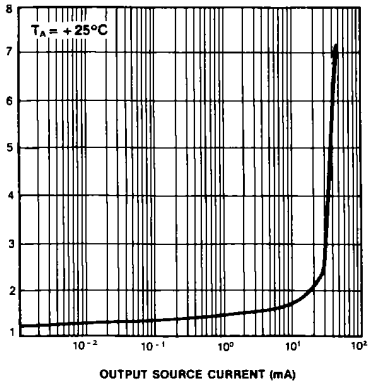



**Figure 5. Output Characteristics vs Current Sourcing**

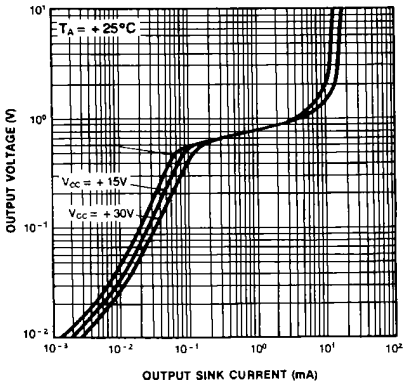



**Figure 6. Output Characteristics vs Current Sinking**

## Typical Performance Characteristics (Continued)

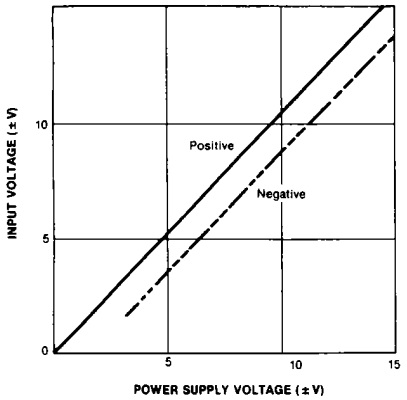



Figure 7. Input Voltage Range vs Supply Voltage

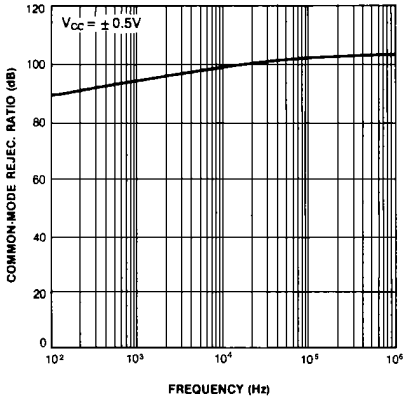



Figure 8. Common-Mode Rejection Ratio

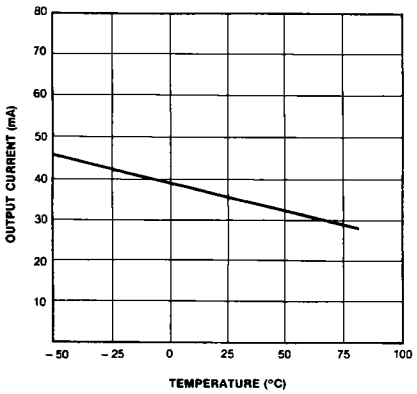



Figure 9. Output Current vs Temperature (Current Limiting)

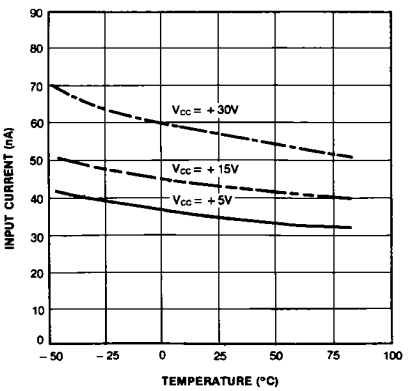



Figure 10. Input Current vs Temperature

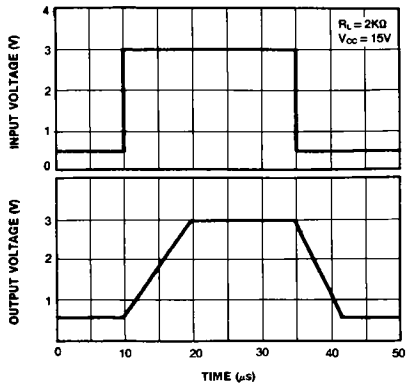



Figure 11. Voltage Follower Pulse Response

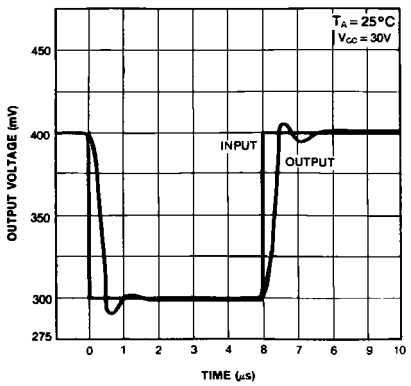


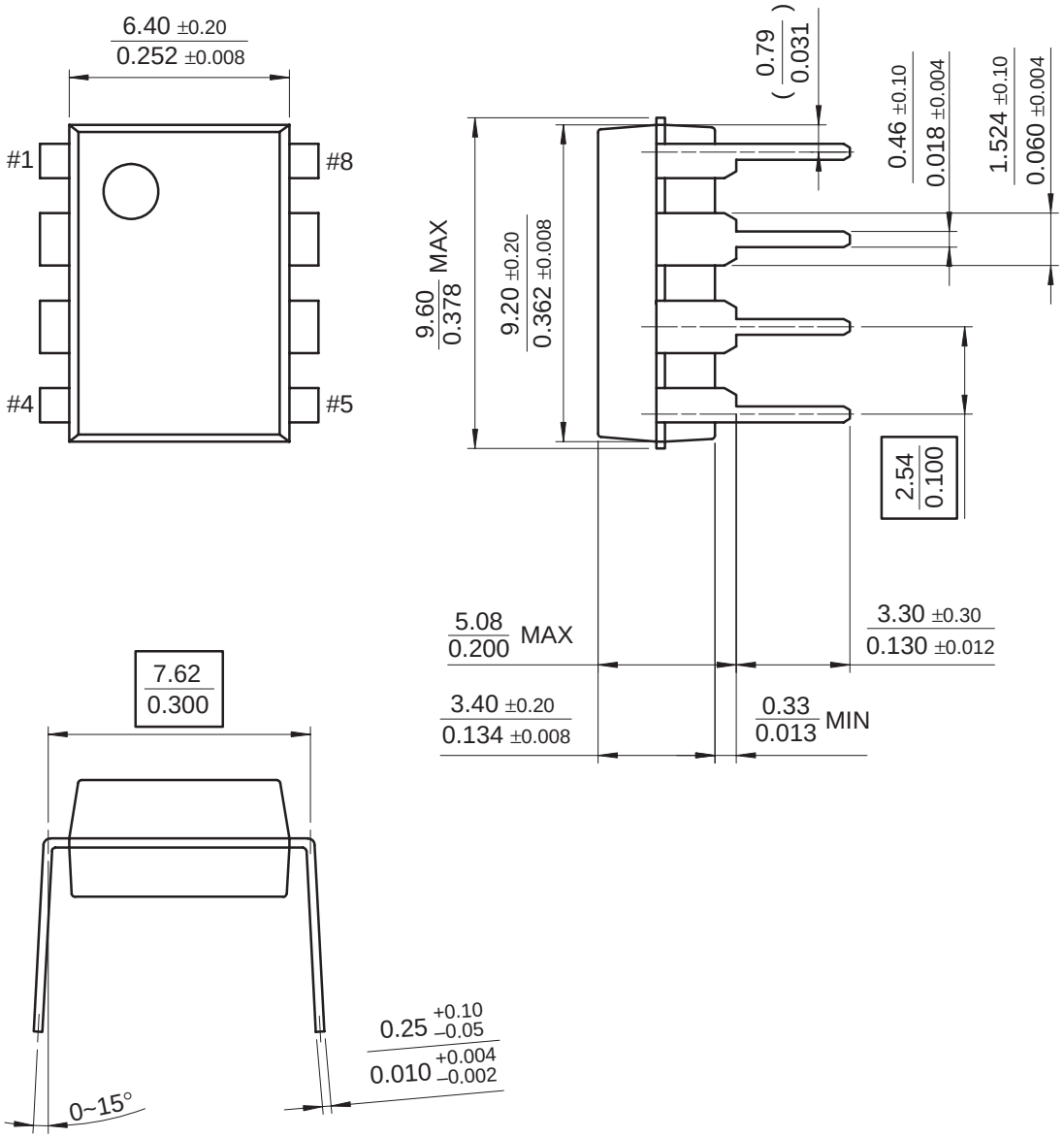

Figure 12. Voltage Follower Pulse Response (Small Signal)

# Mechanical Dimensions

## Package

**Dimensions in millimeters**

## 8-DIP

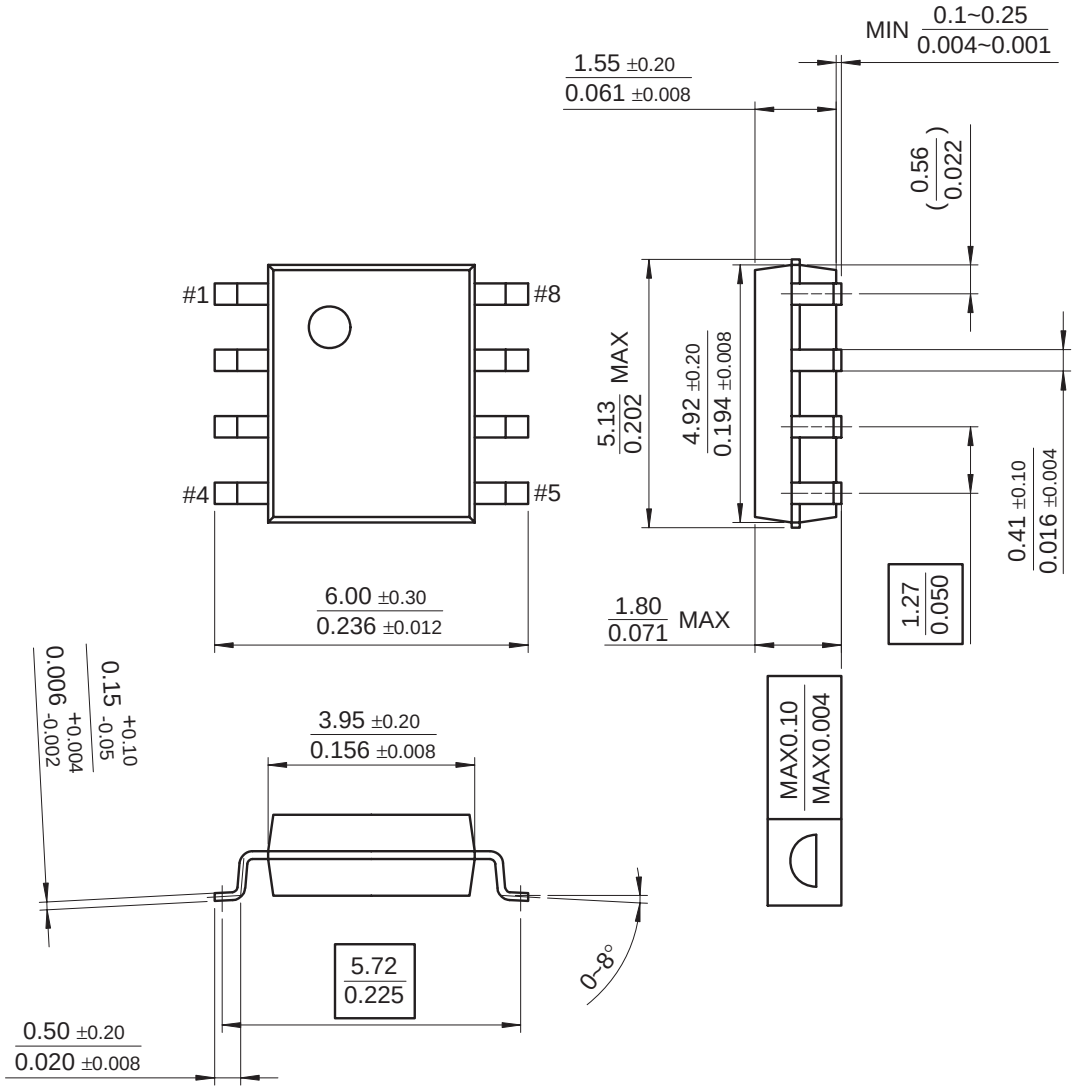


## Mechanical Dimensions (Continued)

### Package

**Dimensions in millimeters**

# 8-SOIC



# Ordering Information

| Product Number | Package | Operating Temperature |
|---|---|---|
| KA358 | 8-DIP | 0 ~ +70°C |
| KA358A | | |
| KA358D | 8-SOIC | |
| KA358AD | | |
| KA258D | 8-SOIC | -25 ~ +85°C |
| KA258AD | | |
| KA2904 | 8-DIP | -40 ~ +85°C |
| KA2904D | 8-SOIC | |

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