## DESCRIPTION

The AO4348 offers low voltage operation and rail-to-rail input and output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (1.1MHz) and slew rate of 0.5V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

The devices are ideal for sensor interfaces, active filters, and portable applications. The AO4348 operational amplifiers is specified at the full temperature range of −40°C to +125°C under single or dual power supplies of 2.2V to 5.5V.

The AO4348 is available in SOP14 and TSSOP14 packages.

## ORDERING INFORMATION

| Package Type | Part Number | |
|---|---|---|
| SOP14<br>SPQ:4,000pcs/Reel | M14 | AO4348M14VR |
| TSSOP14<br>SPQ:4,000pcs/Reel | TMX14 | AO4348TMX14VR |
| Note | V: Halogen free Package<br>R: Tape & Reel | |
| AiT provides all RoHS products | | |

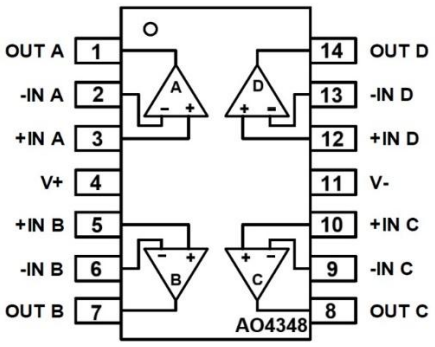
## FEATURES

- High Gain Bandwidth:1.1MHz
- Rail-to-Rail Input and Output 0.6mV Typical Vos
- Input Voltage Range: -0.1V to +5.6V with Vs = 5.5V
- Supply Range: +2.2V to +5.5V
- Specified up to +125°C

## APPLICATION

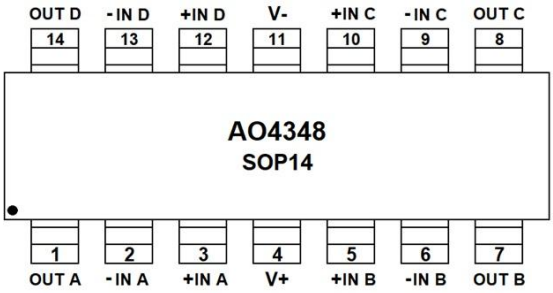
- Sensors
- Photodiode Amplification
- Active filters
- Test Equipment
- Driving A/D Converters

## TYPICAL APPLICATION



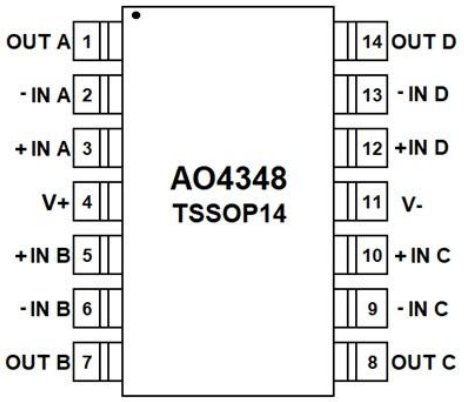

SOP14/TSSOP14

## PIN DESCRIPTION




SOP14, M14

Top View




TSSOP14, TMX14

Top View

| PIN# | | Symbol | I/O | Function |
|---|---|---|---|---|
| SOP14 | TSSOP14 | | | |
| 1 | 1 | OUT A | O | Output, Channel A |
| 2 | 2 | -IN A | I | Inverting Input, Channel A |
| 3 | 3 | +IN A | I | Noninverting Input, Channel A |
| 4 | 4 | V+ | - | Positive (Highest) Power Supply |
| 5 | 5 | +IN B | I | Noninverting Input, Channel B |
| 6 | 6 | -IN B | I | Inverting Input, Channel B |
| 7 | 7 | OUT B | O | Output, Channel B |
| 8 | 8 | OUT C | O | Output, Channel C |
| 9 | 9 | -IN C | I | Inverting Input, Channel C |
| 10 | 10 | +IN C | I | Noninverting Input, Channel C |
| 11 | 11 | V- | - | Negative (Lowest) Power Supply |
| 12 | 12 | +IN D | I | Noninverting Input, Channel D |
| 13 | 13 | -IN D | I | Inverting Input, Channel D |
| 14 | 14 | OUT D | O | Output, Channel D |

## ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range (unless otherwise noted)

| | | |
|---|---|---|
| Supply, $V_S$ =(V+) - (V-), Voltage | | 7.0V |
| Signal Input Pin, Voltage(1) | | (V-)-0.5 to (V+) +0.5V |
| Signal Output Pin, Voltage(2) | | (V-)-0.5 to (V+) +0.5V |
| Signal Input Pin, Current(1) | | ±10mA |
| Signal Output Pin, Current(2) | | ±100mA |
| Output Short-Circuit, Current(3) | | Continuous |
| **Package Thermal Resistance** | | |
| $R_{\theta JA}$, Junction-to-ambient thermal resistance | SOP14 | 83.8℃/W |
| | TSSOP14 | 120.8℃/W |
| $R_{\theta JC(top)}$, Junction-to-case(top) thermal resistance | SOP14 | 70.7℃/W |
| | TSSOP14 | 34.3℃/W |
| $R_{\theta JB}$, Junction-to-board thermal resistance | SOP14 | 59.5℃/W |
| | TSSOP14 | 62.8℃/W |
| $\Psi_{JT}$, Junction-to-top characterization parameter | SOP14 | 11.6℃/W |
| | TSSOP14 | 1.0℃/W |
| $\Psi_{JB}$, Junction-to-board characterization parameter | SOP14 | 37.7℃/W |
| | TSSOP14 | 56.5℃/W |
| $T_A$, Operating Range | | -40℃ ~ +125℃ |
| $T_{STG}$, Storage Temperature | | -65℃ ~ +150℃ |
| $T_J$, Junction Temperature | | +150℃ |
| **ESD Ratings** | | |
| $V_{(ESD)}$, Electrostatic Discharge | Human-Body Model (HBM) | ±5000V |
| | Machine Model (MM) | ±400V |

Stresses above 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 in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

(1) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less.

(2) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to ±100mA or less.

(3) Short-circuit to ground, one amplifier per package.

## RECOMMENDED OPERATING CONDITIONS

Over operating free-air temperature range (unless otherwise noted)

| Parameter | Symbol | Conditions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_S$ =(V+) - (V-) | Single-Supply | 2.2 | - | 5.5 | V |
| | | Dual-Supply | ±1.1 | | ±2.75 | |
| Specified Temperature | | | -40 | | +125 | ℃ |

## ELECTRICAL CHARACTERISTICS

At $T_A$ = +25℃, $V_S$=5V, $R_L$ = 10kΩ connected to $V_S$/2, and $V_{OUT}$ = $V_S$/2, unless otherwise noted

| Parameter | Symbol | Conditions | Temp | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| **POWER SUPPLY** | | | | | | | |
| Operating Voltage Range | $V_S$ | | 25℃ | 2.2 | - | 5.5 | V |
| Quiescent Current/Amplifier | $I_Q$ | | 25℃ | - | 58 | 80 | uA |
| Power-Supply Rejection Ratio | PSRR | $V_S$=2.2V to 5.5V, $V_{CM}$=(V-)+0.5V | 25℃ | 72 | 90 | - | dB |
| | | | -40℃~125℃ | 65 | - | - | |
| **INPUT** | | | | | | | |
| Input Offset Voltage | $V_{OS}$ | | 25℃ | - | 0.6 | 3.0 | mV |
| I Input Offset Voltage Average Drift | $V_{OS}$, $T_C$ | | -40℃~125℃ | - | 2 | - | uV/℃ |
| Input Bias Current | $I_B$ | | 25℃ | - | 1 | 10 | pA |
| Input Offset Current | $I_{OS}$ | | 25℃ | - | 1 | 10 | pA |
| Common-Mode Voltage Range | $V_{CM}$ | $V_S$= 5.5V | 25℃ | -0.1 | - | 5.6 | V |
| Common-Mode Rejection Ratio | CMRR | $V_S$= 5.5V, $V_{CM}$=-0.1V ~ 4V | 25℃ | 71 | 90 | - | dB |
| | | | -40℃~125℃ | 68 | - | - | |
| | | $V_S$= 5.5V, $V_{CM}$=-0.1V ~ 5.6V | 25℃ | 60 | 80 | - | |
| | | | -40℃~125℃ | 57 | - | - | |
| **OUTPUT** | | | | | | | |
| Open-Loop Voltage Gain | $A_{OL}$ | RL=2KΩ, Vo=0.15V to 4.85V | 25℃ | 94 | 105 | - | dB |
| | | | -40℃~125℃ | 85 | - | - | |
| | | RL=10KΩ, Vo=0.05V to 4.95V | 25℃ | 100 | 110 | - | |
| | | | -40℃~125℃ | 90 | - | - | |
| Output Swing from Rail | | $R_L$=2KΩ | 25℃ | - | 25 | - | mV |
| | | $R_L$=10KΩ | 25℃ | - | 8 | - | |
| Output Short-Circuit Current | $I_{OUT}$ | | 25℃ | - | 55 | - | mA |
| **FREQUENCY RESPONSE** | | | | | | | |
| Slew Rate | $S_R$ | | 25℃ | - | 0.5 | - | V/us |
| Gain-Bandwidth Product | $G_{BP}$ | | 25℃ | - | 1.1 | - | MHz |
| Phase Margin | PM | | 25℃ | - | 64 | - | ° |
| Setting Time,0.1% | $t_S$ | | | - | 1.3 | - | us |
| Overload Recovery Time | | $V_{IN}$·Gain≥$V_S$ | | - | 2.3 | - | us |
| **NOISE** | | | | | | | |
| Input Voltage Noise Density | $e_n$ | f=1KHz | 25℃ | - | 22 | - | nV/$\sqrt{Hz}$ |
| | | f=10KHz | 25℃ | - | 20 | - | |

## TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A$ = 25℃, $V_S$=5V, $R_L$ = 10kΩ connected to $V_S$/2, $V_{OUT}$ = $V_S$/2, unless otherwise noted

Fig 1. Open-Loop Gain and Phase vs. Frequency

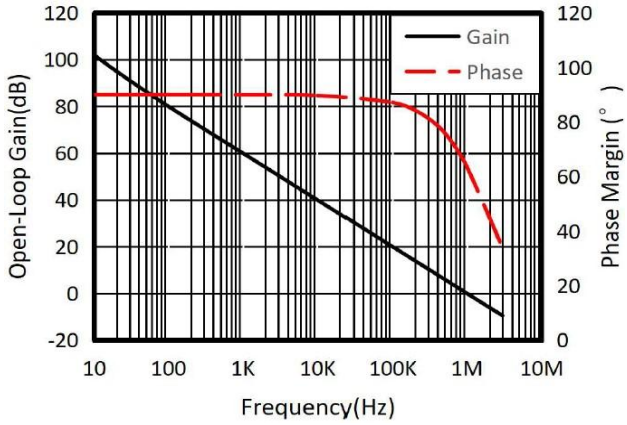



Fig 2. Common-Mode Rejection Ratio vs. Frequency

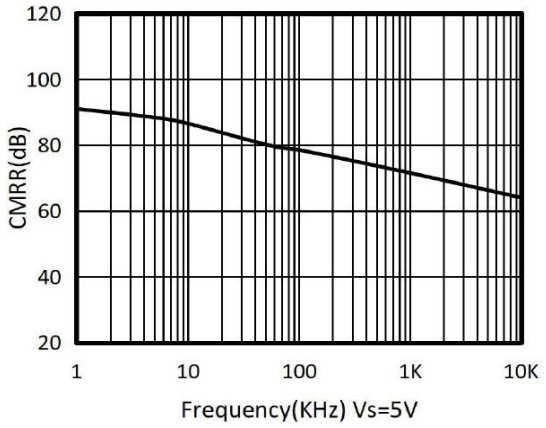



Fig 3. Input voltage Noise Spectral Density vs. Frequency

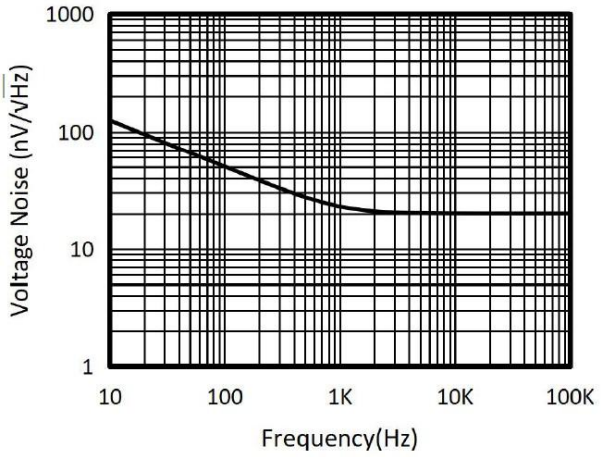



Fig 4. Power-Supply Rejection Ratio vs. Frequency

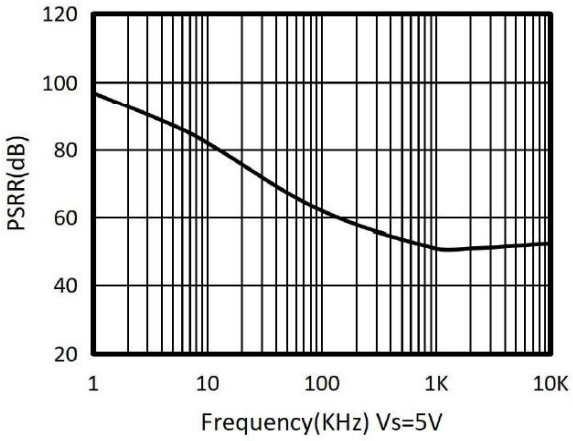



Fig 5. Quiescent Current vs. Temperature

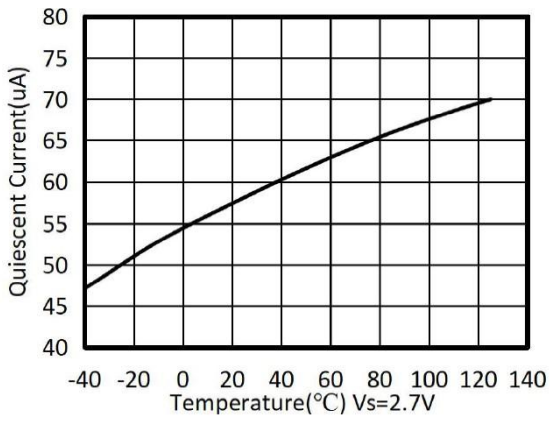



Fig 6. Quiescent Current vs. Temperature

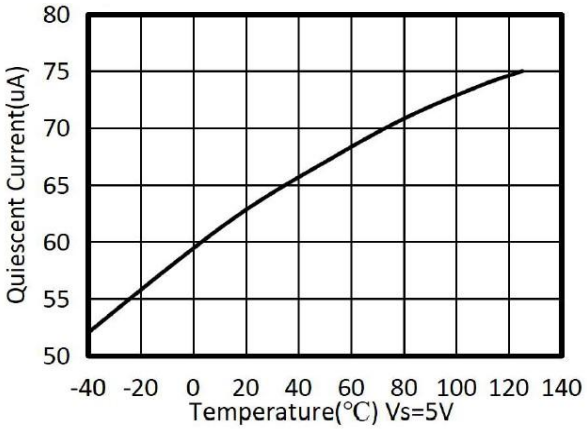


Fig 7. Sink Current vs. Temperature

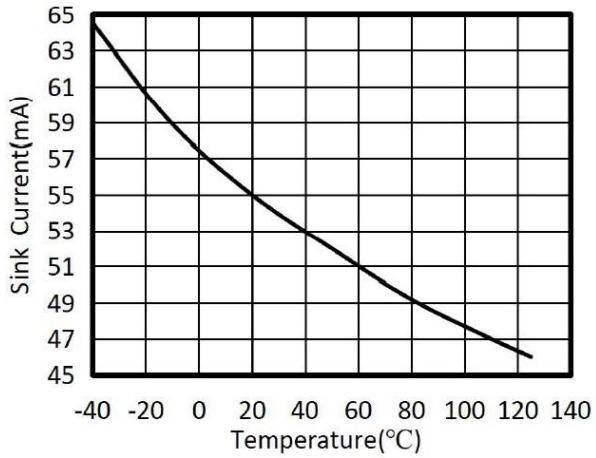



Fig 8. Source Current vs. Temperature

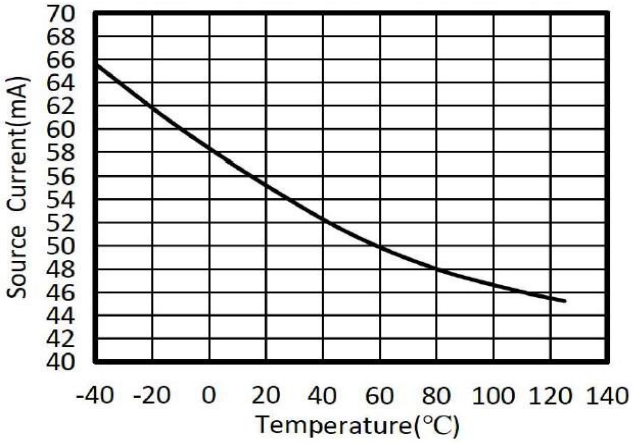



Fig 9. Input Bias Current vs. Temperature

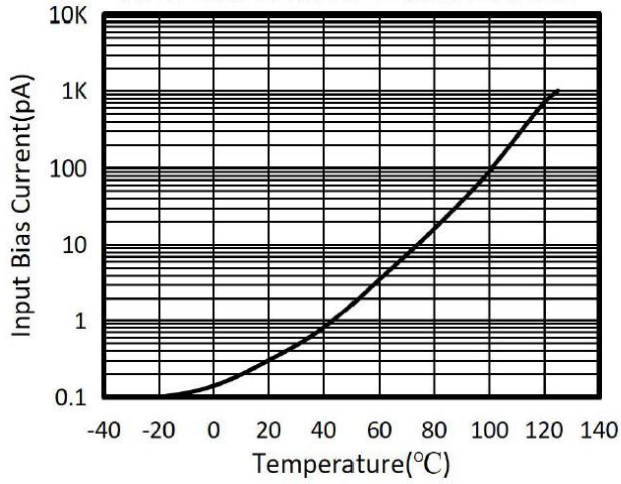



Fig 10. Small-Signal Step Response

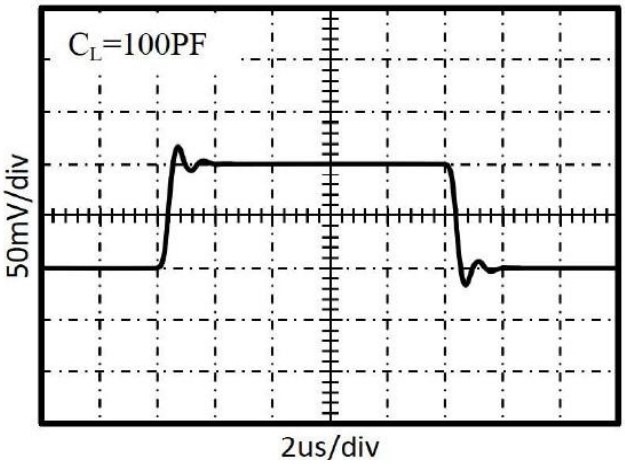



Fig 11. Large-Signal Step Response

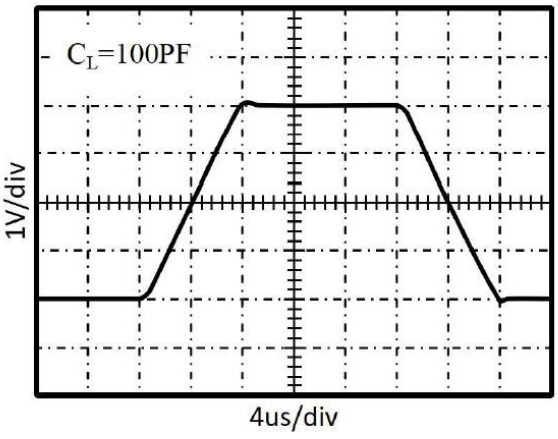



Fig 12. Positive Overvoltage Recovery

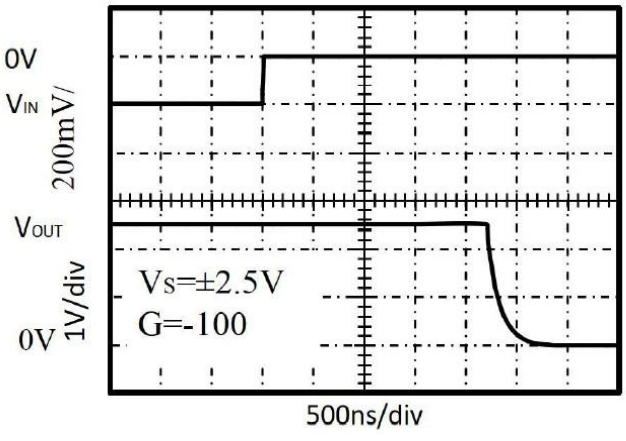


Fig 13. Negative Overvoltage Recovery

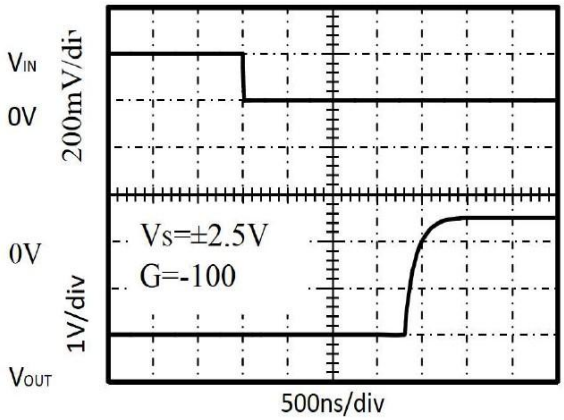
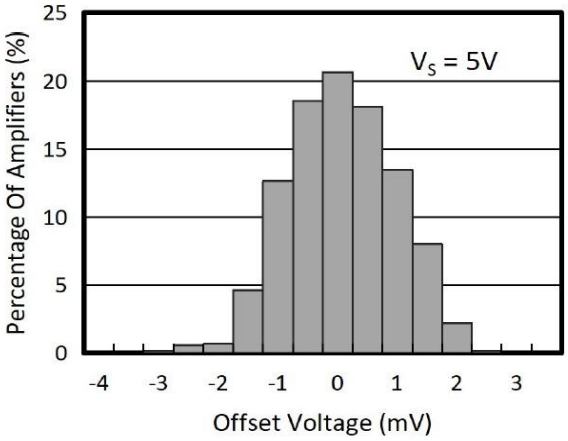
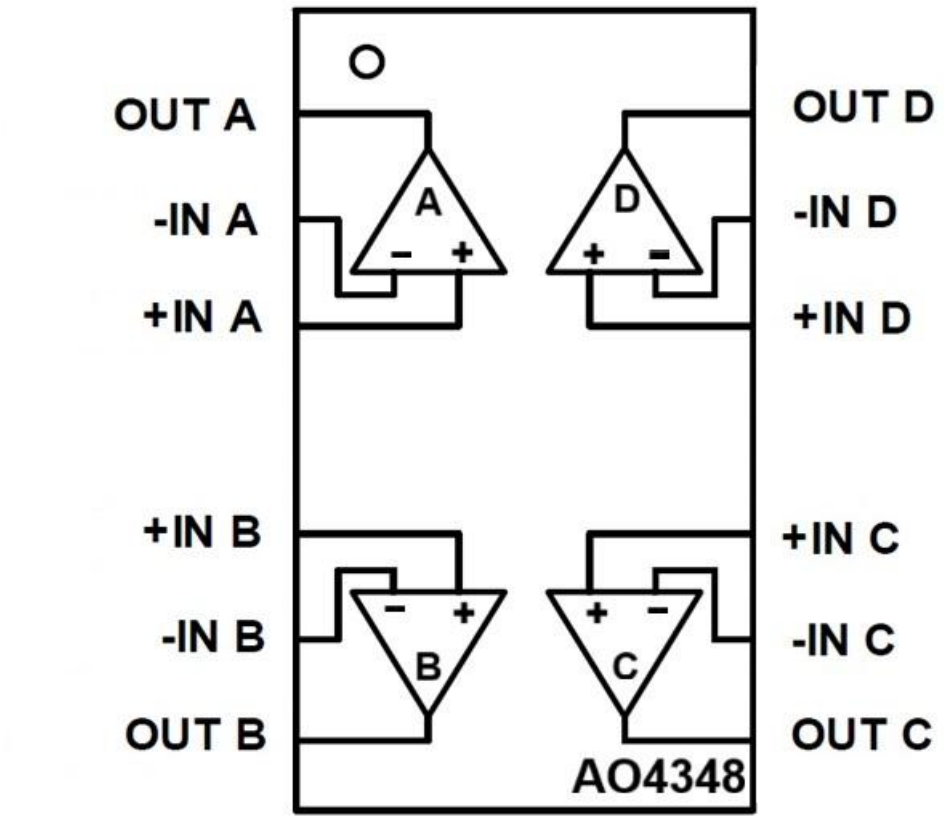



Fig 14. Offset Voltage Production Distribution




## BLOCK DIAGRAM



## DETAILED INFORMATION

### Application Notes

The AO4348 is high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.2V to 5.5V (±1.1V to ±2.75V). Supply voltages higher than 7V (absolute maximum) can permanently damage the amplifier. Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications. Good layout practice mandates use of a 0.1uF capacitor place closely across the supply pins.

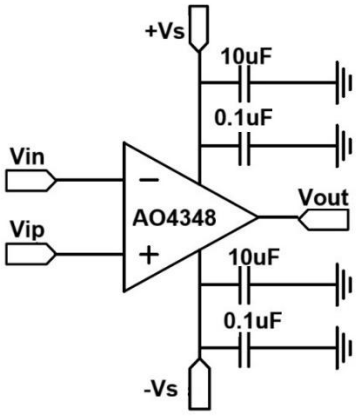



Figure1. Amplifier with Bypass Capacitors

### Instrumentation Amplifier

In the three-op amp, instrumentation amplifier configuration shown in Figure2

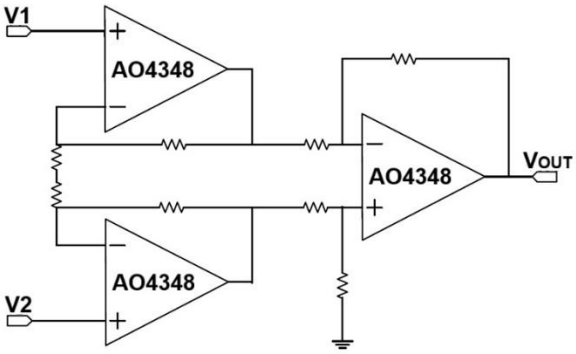



Figure2. Amplifier instrumentation amplifier

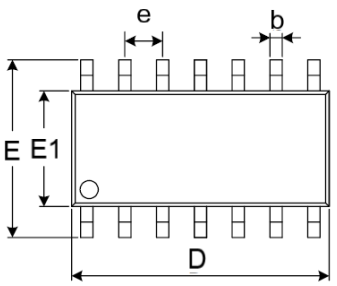
### Layout Guidelines

Attention to good layout practices is always recommended. Keep traces short. When possible, use a PCB ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1uF capacitor closely across the supply pins.

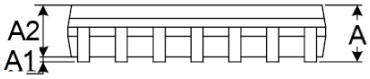
These guidelines should be applied throughout the analog circuit to improve performance and provide benefits such as reducing the EMI susceptibility.

## PACKAGE INFORMATION

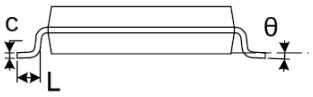
Dimension in SOP14 (Unit: mm)




TOP VIEW

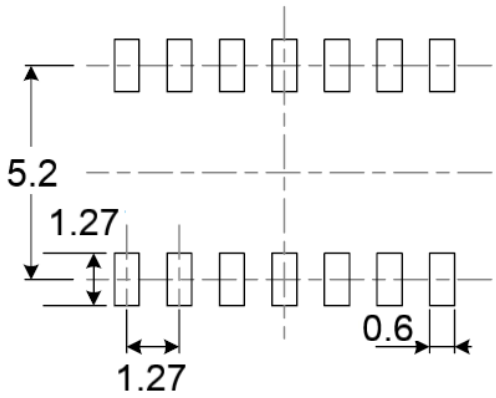



BOTTOM VIEW



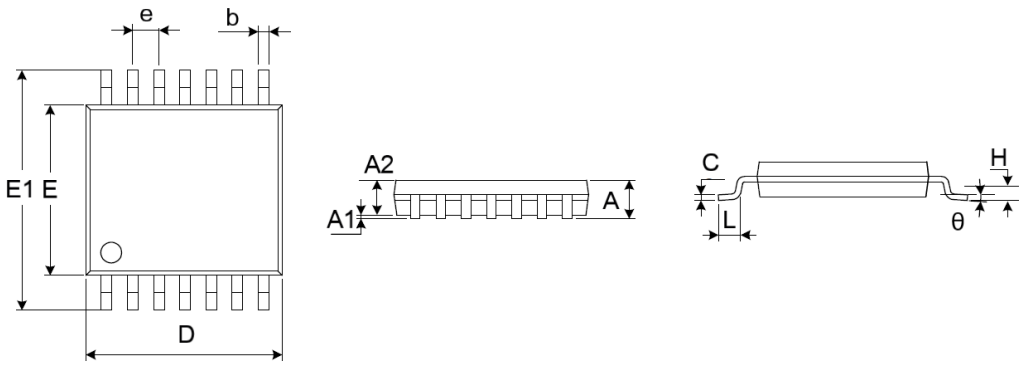

SIDE VIEW

Recommended Land Pattern



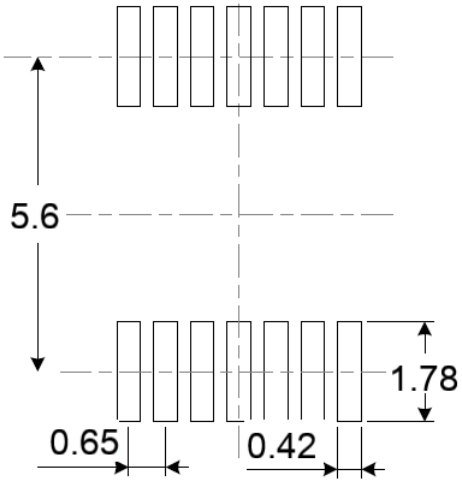

| Symbol | Millimeters | |
|---|---|---|
| | Min | Max |
| A | 1.350 | 1.750 |
| A1 | 0.100 | 0.250 |
| A2 | 1.350 | 1.550 |
| b | 0.310 | 0.510 |
| c | 0.100 | 0.250 |
| D | 8.450 | 8.850 |
| e | 1.270 BSC | |
| E | 5.800 | 6.200 |
| E1 | 3.800 | 4.000 |
| L | 0.400 | 1.270 |
| θ | 0° | 8° |

Dimension in TSSOP14 (Unit: mm)




TOP VIEW BOTTOM VIEW SIDE VIEW

Recommended Land Pattern




| Symbol | Millimeters | |
|---|---|---|
| | Min | Max |
| A | - | 1.200 |
| A1 | 0.050 | 0.150 |
| A2 | 0.800 | 1.050 |
| b | 0.190 | 0.300 |
| c | 0.090 | 0.200 |
| D | 4.860 | 5.100 |
| E | 4.300 | 4.500 |
| E1 | 6.250 | 6.550 |
| e | 0.650 BSC | |
| L | 0.500 | 0.700 |
| H | 0.25 TYP | |
| θ | 1° | 7° |

## IMPORTANT NOTICE

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