

## Quad Ground Sense Operational Amplifier

The CO324 is monolithic IC with four built-in operational amplifiers featuring internal phase compensation.

Either a dual or single power supply can be driven, and these products can be driven by a digital system 5V single power supply. These products can be used in a wide range of administrative and industrial applications, including transducer amplifiers and DC amplifiers.

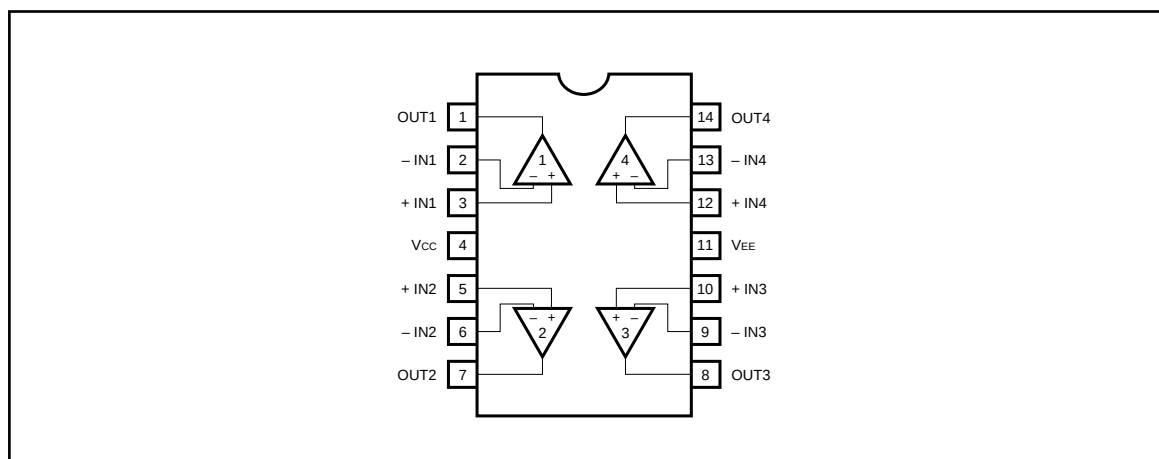
### ●Applications

Ground sensing type pre-amplifiers  
Active filters  
DC amplifiers  
Pulse generators.

### ●Features

- 1) Wide range of operating power supply voltages and single power supply drive enabled.  
(single power supply: 3 to 30V, dual power supply:  $\pm 1.5$  to  $\pm 15$ V)
- 2) Common-mode input voltage can be operated from the ground level.
- 3) Differential input voltage can be operated up to the power supply voltage level.
- 4) Low current dissipation. ( $I_Q = 0.6\text{mA}$ )
- 5) Low offset voltage and offset current. ( $V_{IO} = 2\text{mV}$ ,  $I_{IO} = 5\text{nA typ.}$ )
- 6) Four operational amplifiers with phase compensation are built into the DIP / SOP Pin 14.
- 7) Compatible with model 324 operational amplifiers of other manufacturers.

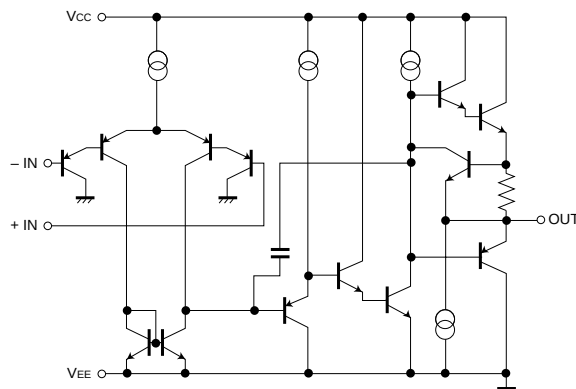
### ●Block diagram



\* All specs and applications shown above subject to change without prior notice.

## Quad Ground Sense Operational Amplifier

### ● Internal circuit configuration



### ● Absolute maximum rating ( $T_a = 25^\circ\text{C}$ )

| Parameter                  | Symbol | Limits         |                | Unit             |
|----------------------------|--------|----------------|----------------|------------------|
|                            |        | CO324 (DIP-14) | CO324 (SOP-14) |                  |
| Power supply voltage       | Vcc    | 36( $\pm 16$ ) | 36( $\pm 16$ ) | V                |
| Power dissipation          | Pd     | 720*           | 450*           | mW               |
| Differential input voltage | VID    | $\pm V_{CC}$   | $\pm V_{CC}$   | V                |
| Common-mode input voltage  | VI     | -0.3~Vcc       | -0.3~Vcc       | V                |
| Operating temperature      | Topr   | -40~+85        | -40~+85        | $^\circ\text{C}$ |
| Storage temperature        | Tstg   | -55~+125       | -55~+125       | $^\circ\text{C}$ |

\* Refer to the Pd characteristics diagram.

### ● ORDERING INFORMATION

CO324 X  
 BLANK: SO-14  
 N:DIP14  
 A:SO-14 & TAPING

\* All specs and applications shown above subject to change without prior notice.

## Quad Ground Sense Operational Amplifier

●Electrical characteristics (unless otherwise noted,  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ )

| Parameter                            |        | Symbol    | Min.           | Typ. | Max.           | Unit | Conditions                                  |
|--------------------------------------|--------|-----------|----------------|------|----------------|------|---------------------------------------------|
| Input offset voltage                 |        | $V_{IO}$  | —              | 2    | 7              | mV   | $R_s = 50\Omega$                            |
| Input offset current                 |        | $I_{IO}$  | —              | 5    | 50             | nA   |                                             |
| Input bias current                   |        | $I_b$     | —              | 45   | 250            | nA   | *1                                          |
| Common-mode input voltage            |        | $V_{ICM}$ | 0              | —    | $V_{CC} - 1.5$ | V    |                                             |
| Common-mode rejection ratio          |        | CMRR      | 65             | 75   | —              | dB   |                                             |
| High-amplitude voltage gain          |        | $A_{VOL}$ | 87             | 100  | —              | dB   | $R_L \geq 2k\Omega$ , $V_{CC} = 15\text{V}$ |
| Power supply voltage rejection ratio |        | PSRR      | 65             | 100  | —              | dB   | $R_s = 50\Omega$                            |
| Quiescent current                    |        | $I_Q$     | —              | 0.6  | 2.0            | mA   | $R_L = \infty$ , on All Op - Amps           |
| Maximum output voltage               |        | $V_{OH}$  | $V_{CC} - 1.5$ | —    | —              | V    | $R_L = 2k\Omega$                            |
|                                      |        | $V_{OL}$  | —              | —    | 0.25           | V    | $R_L = \infty$                              |
| Maximum output current               | Source | $I_{OH}$  | 20             | 35   | —              | mA   | $V_O = 0$                                   |
|                                      | Sink   | $I_{OL}$  | 10             | 20   | —              | mA   | $V_O = V_{CC}$                              |
| Channel separation                   |        | CS        | —              | 120  | —              | dB   | $f = 1\text{kHz}$<br>input conversion       |

\*1 Because the first stage is configured with a PNP transistor, input bias current is from the IC.

●Electrical characteristic curves

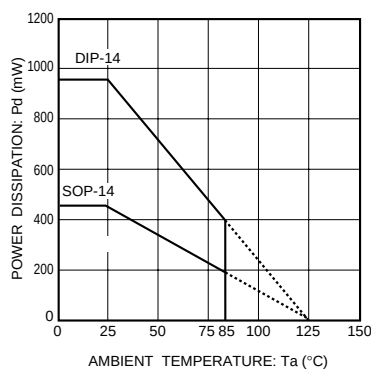


Fig.1 Power dissipation vs. ambient temperature

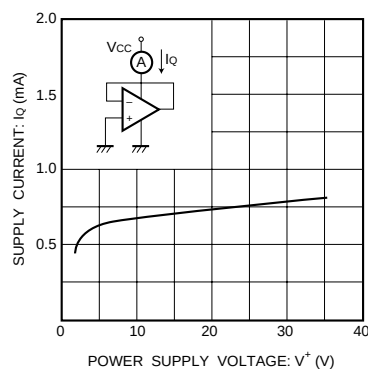


Fig.2 Quiescent current vs. power supply voltage

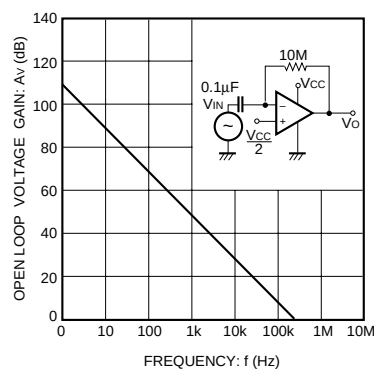


Fig.3 Open loop voltage gain vs. frequency

\* All specs and applications shown above subject to change without prior notice.

## Quad Ground Sense Operational Amplifier

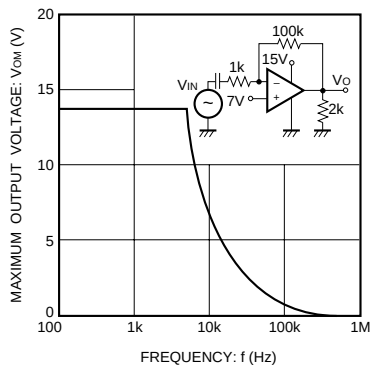


Fig.4 Maximum output voltage vs. frequency

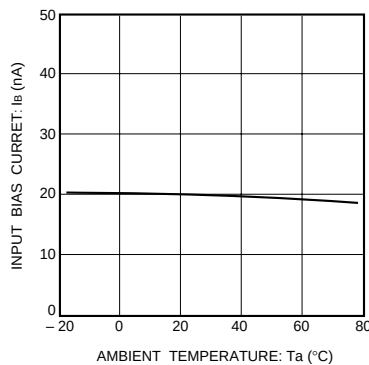


Fig.5 Input bias current vs. ambient temperature

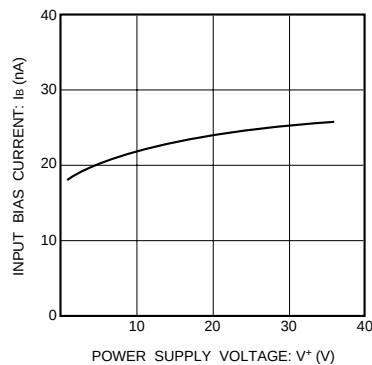


Fig.6 Input bias current vs. power supply voltage

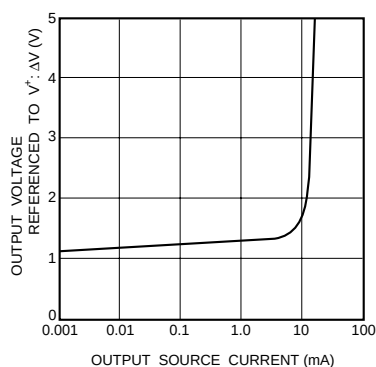


Fig.7 Potential difference during power supply output vs. output source current

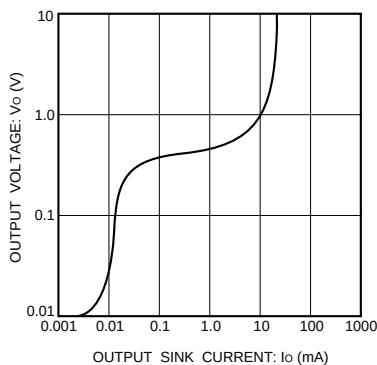


Fig.8 Output voltage vs. output sink current

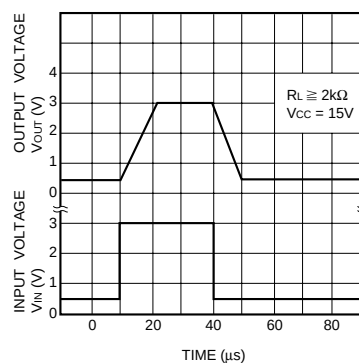


Fig.9 Output response characteristics

\* All specs and applications shown above subject to change without prior notice.

## Quad Ground Sense Operational Amplifier

### ●Operation notes

#### (1) Unused circuit connections

If there are any circuits which are not being used, we recommend making connections as shown in Figure 10, with the non-inverted input pin connected to the potential within the in-phase input voltage range ( $V_{ICM}$ ).

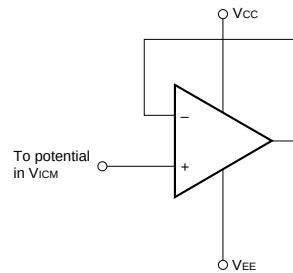
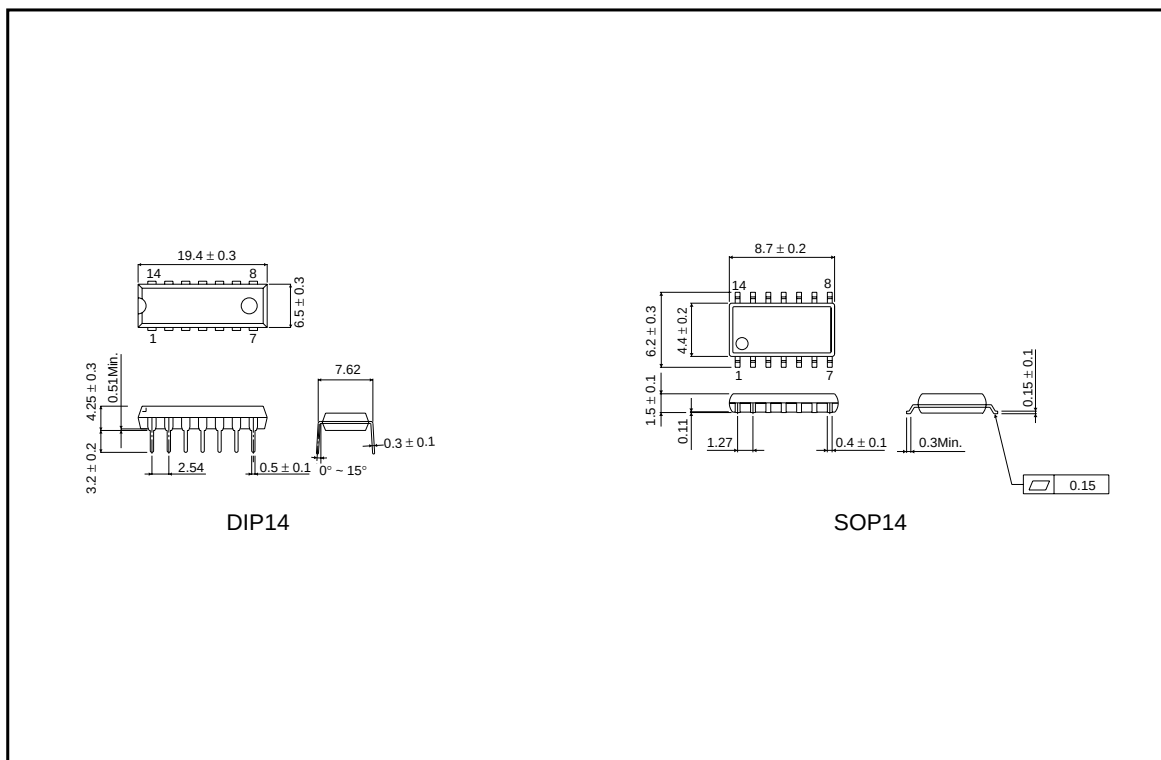


Fig.10 Unused circuit connections

### ●External dimensions (Units: mm)



\* All specs and applications shown above subject to change without prior notice.