# HX321-ST general purpose rail-to-rail operational amplifier

## Summarize

The HX321-ST (Single Channel) is a feature-rich, efficient universal rail-to-rail operational amplifier suited for modern electronic devices. Its rail-to-rail input/output, wide input common-mode voltage range, large output swing, and flexible operating voltage (2.1V to 5.5V) make it versatile.

With a gain bandwidth product of 1.1MHz and low power consumption (45 microamps), it's ideal for high-speed, low-energy applications. Its ultra-low input bias current (10 picoamps) suits high-precision circuits like integrators, photodiode amplifiers, and piezoelectric sensors.

The op amp's rail-to-rail capabilities allow for flexibility in single-supply systems. Thus, the HX321-ST can be used as a buffer in single-power systems, maintaining signal integrity and stability.

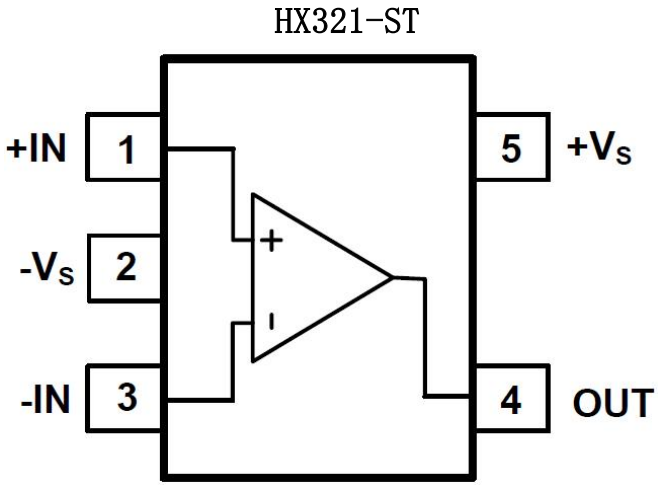
## Peculiarity

- Track-to-track input/output
- Low power consumption：45uA
- A typical value for low output offset voltage is 0.8 millivolts.
- Operating voltage of 2.1V~5.5V
- Gain-bandwidth product 1.1MHz
- Low input bias current: 10pA level
- Wide input voltage：-0.1V to 5.6V（VS=5.5V）
- Unit gain stabilization

## Apply

- ASIC input and output op amp
- Sensor interface, piezoelectric sensing amplifier
- Audio output
- Medical device
- Mobile communication, DSP interface
- Portable systems, battery powered devices
- Smoke detector, laptop, PCMCIA card

## Pin arrangement diagram



| Limiting condition | |
|---|---|
| Supply voltage（V+ to V-） | 7.5 V |
| Input common-mode voltage | (-VS) - 0.5 V to (+VS)+0.5V |
| Storage temperature | -50℃ to +150℃ |
| Junction temperature | +150℃ |
| Operating temperature | -40℃ to +85℃ |
| Lead Temperature Range (Soldering 10 sec) | 250℃ |

## Attention!

Exceeding the above limit value may cause permanent damage to the chip; Working for a long time under the limit value condition will also affect the reliability of the device. Precision HX321-ST devices may be damaged in the case of small static electricity, and small parameter changes may make the performance of the entire circuit substandard, so it is recommended to take certain preventive measures for the circuit. At the same time, the correct installation of the whole machine will also reduce the damage.

## Electrical performance parameters: VS = +5V

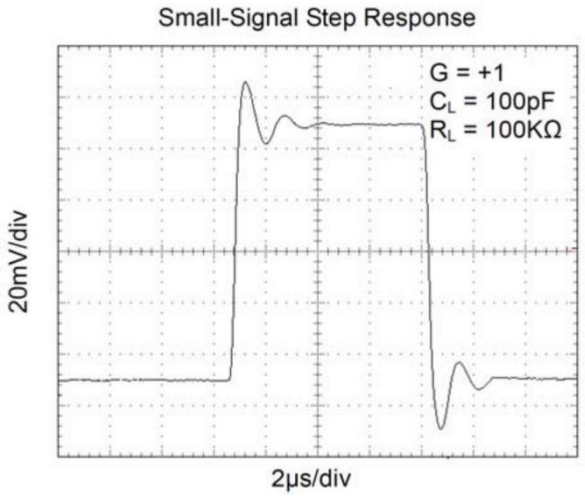
(No special instructions connect Vs/2 at RL=100kΩ, Vout = Vs/2, Ta=25℃)

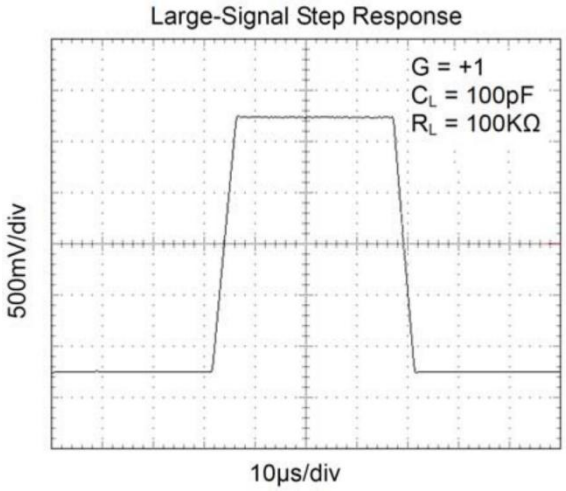
| Argument | Test condition | HX321-ST 25 ℃ | | | |
|---|---|---|---|---|---|
| | | MIN | TYP | MAX | UNIT |
| **Input parameter** | | | | | |
| Input Offset voltage (VOS) | | | ±0.8 | ±5 | mV |
| Input Bias Current (IB) | | | 10 | | pA |
| Input offset current | | | 10 | | pA |
| Input Common Mode Voltage (Vcm) | VS = 5.5V | | -0.1 to +5.6 | | V |
| Common mode rejection ratio (CMRR) | VS = 5.5V, VCM = - 0.1V to 4V | 62 | 70 | | dB |
| | VS = 5.5V, VCM=-0.1V to 5.6V | 56 | 68 | | |
| Open loop gain (AOL) | RL = 5KΩ ,Vo = 0.1V to 4.9V | 70 | 80 | | dB |
| | RL =100KΩ,Vo = 0.035V to 4.96V | 80 | 84 | | |
| Input offset voltage drift (ΔVOS/ΔT) | | | 2.7 | | μV/℃ |
| **Output parameter** | | | | | |
| Output voltage swing | RL = 100KΩ | | 0.008 | | V |
| | RL = 10KΩ | | 0.08 | | |
| Output current (IOUT) | | 18 | 30 | | mA |

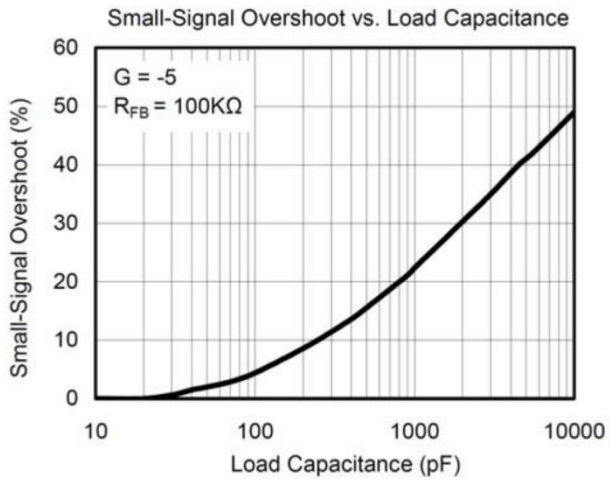
| | | | | | |
|---|---|---|---|---|---|
| **Power supply part** | | | | | |
| Operating voltage range | | 2.1 | | 5.5 | V |
| Power supply rejection ratio (PSRR) | Vs = +2.5 V to + 5.5 V VCM = (-VS) + 0.5V | 80 | | | dB |
| | | 60 | | | |
| Static current /Amplifier (IQ) | IOUT = 0 | | | 45 | μA |
| | | | | 75 | |
| **Dynamic performance** | | | | | |
| Gain-bandwidth product(GBP) | CL = 100pF G = +1 , 2V Output Step | | 1.1 | | MHz |
| Conversionrate(SR) | | | 0.52 | | V/μs |
| **Noise performance** | | | | | |
| Voltagenoisedensity(en) | f = 1kHz | | 27 | | nV/ √Hz |
| | f = 10kHz | | 20 | | |

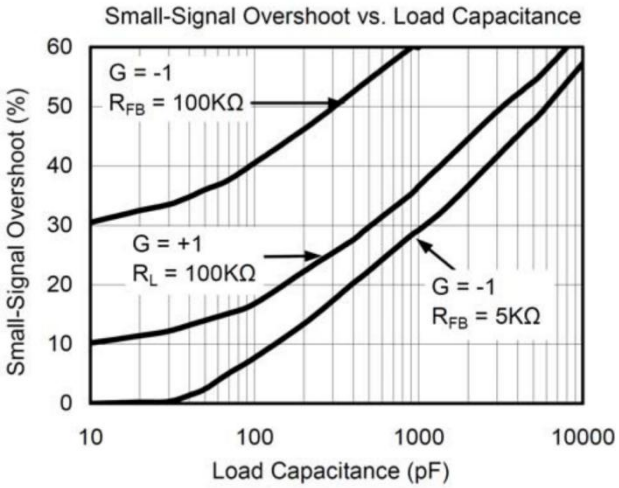
## Typical performance parameter

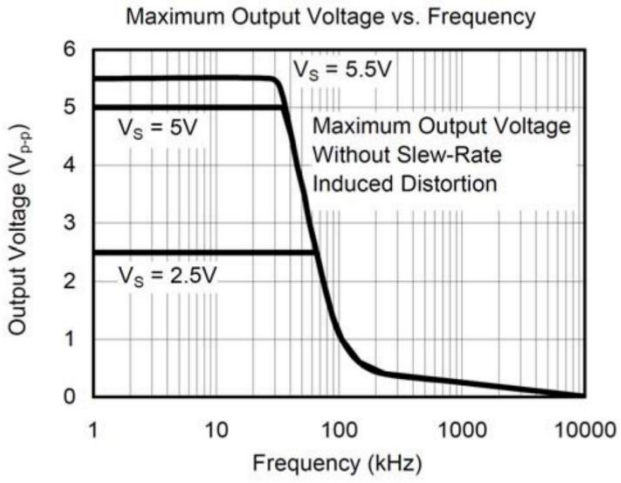
No special instructions TA = +25℃, VS = +5V, and RL = 100kΩ connected to Vs/2

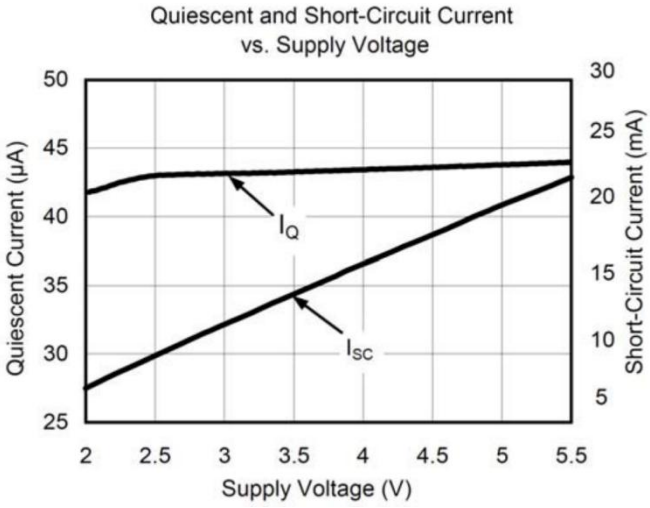


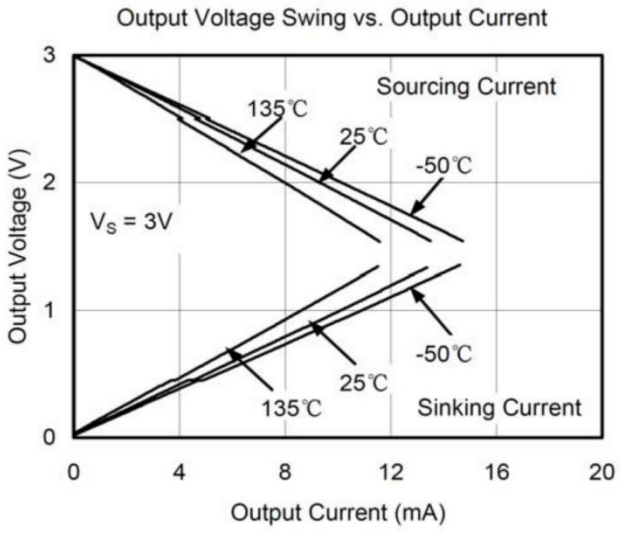



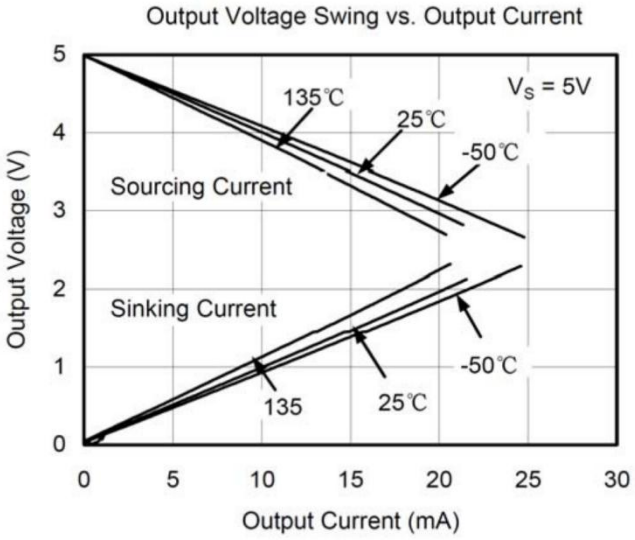

Small-Signal Overshoot vs. Load Capacitance
G = -5
$R_{FB}$ = 100KΩ
Small-Signal Overshoot (%)
Load Capacitance (pF)
0
10
20
30
40
50
60
10
100
1000
10000

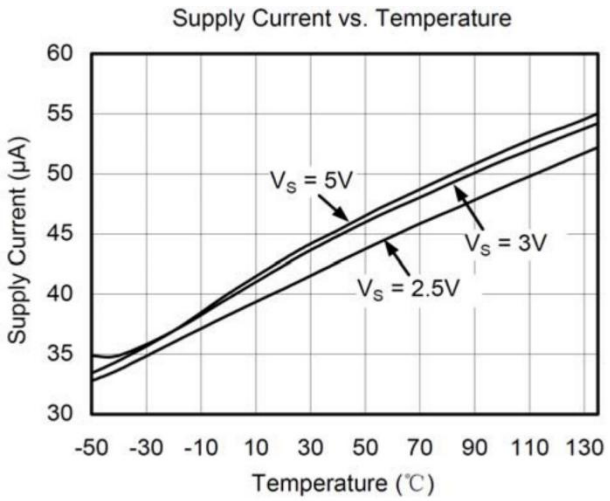

Small-Signal Overshoot vs. Load Capacitance
G = -1
$R_{FB}$ = 100KΩ
G = +1
$R_L$ = 100KΩ
G = -1
$R_{FB}$ = 5KΩ
Small-Signal Overshoot (%)
Load Capacitance (pF)
0
10
20
30
40
50
60
10
100
1000
10000

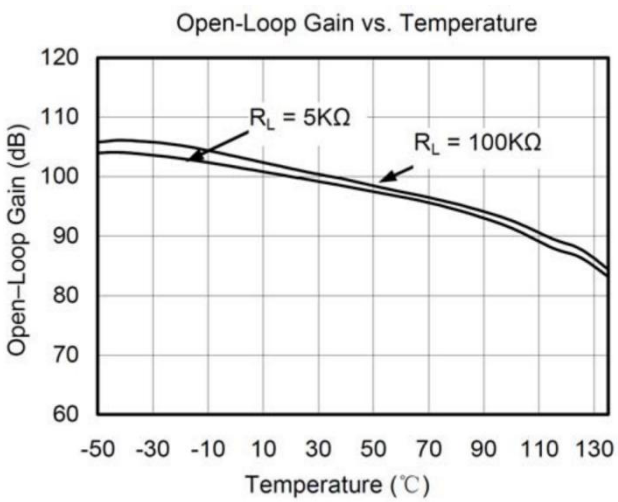

Maximum Output Voltage vs. Frequency
$V_S$ = 5.5V
$V_S$ = 5V
Maximum Output Voltage
Without Slew-Rate
Induced Distortion
$V_S$ = 2.5V
Output Voltage ($V_{p-p}$)
Frequency (kHz)
0
1
2
3
4
5
6
1
10
100
1000
10000

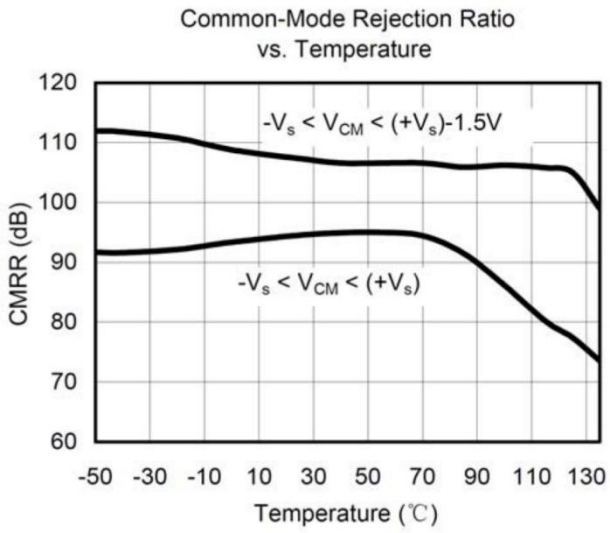

Quiescent and Short-Circuit Current
vs. Supply Voltage
$I_Q$
$I_{SC}$
Quiescent Current (μA)
Short-Circuit Current (mA)
Supply Voltage (V)
25
30
35
40
45
50
5
10
15
20
25
30
2
2.5
3
3.5
4
4.5
5
5.5

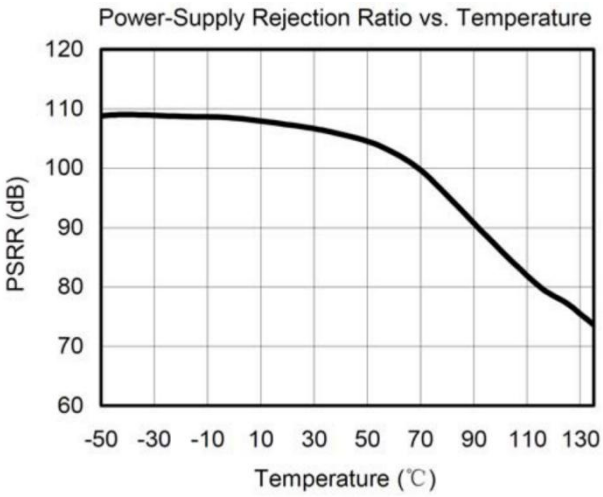

Output Voltage Swing vs. Output Current
Sourcing Current
135℃
25℃
-50℃
$V_S$ = 3V
-50℃
25℃
135℃
Sinking Current
Output Voltage (V)
Output Current (mA)
0
1
2
3
0
4
8
12
16
20


Output Voltage Swing vs. Output Current
$V_S$ = 5V
135℃
25℃
-50℃
Sourcing Current
Sinking Current
-50℃
135
25℃
Output Voltage (V)
Output Current (mA)
0
1
2
3
4
5
0
5
10
15
20
25
30




## Application description

### 1. Drive capacitive load

The HX321-ST can drive a 250pf capacitor at unit-gain without oscillation, but unit-gain followers are sensitive to capacitive loads. Direct driving reduces phase accuracy and may cause oscillations. For larger capacitors, an isolation resistor between the output and capacitor is needed (see Figure 1). Both the isolation resistance (Riso) and capacitance load (CL) should increase together; higher Riso values stabilize the output but reduce the final gain due to voltage division.

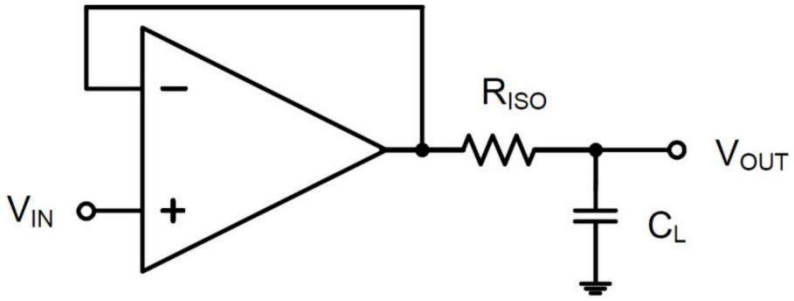



Figure 1, driving a large capacitive load

An improved circuit mode, as shown in Figure 2, provides the accuracy of DC DC and the stability of AC AC. The feedback resistance Rf between the reverse input and output ensures the accuracy of DC. CF and Riso are connected between the reverse input and output, which can offset part of the loss of phase margin in the case of high frequency signals. Thus, the phase margin in the whole feedback loop is guaranteed.

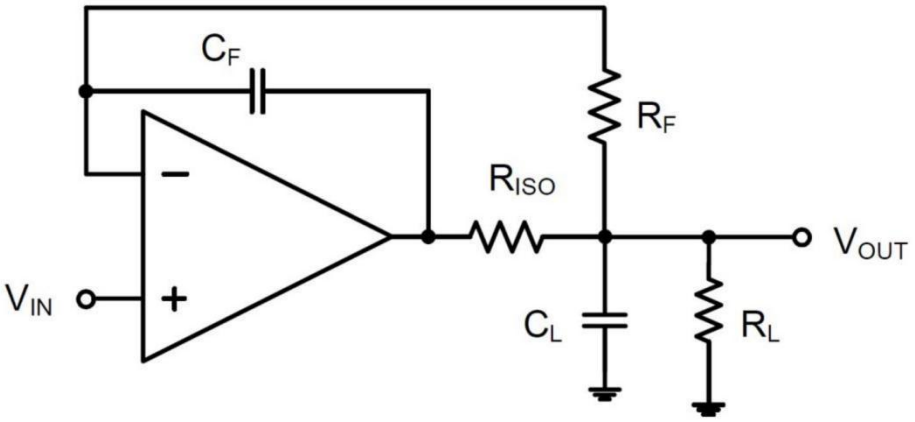



Figure 2, direct drive high capacitance to ensure DC accuracy

For circuits with no buffer configuration, there are two ways to gain the phase margin: a) increase the gain of the amplifier, and b) parallel a capacitor between the feedback resistors to offset the parasitic capacitance.

### 2. Power bypass and layout

The HX321-ST can operate from 2.5V to 5.5V with single power supply or from ±1.25V to ±2.75V with dual power supply. In a single power supply, the bypass capacitor 0.1uF should be close to the VDD pin of the power supply. In the case of dual power supply, both VDD and VSS pins need to be connected to a 0.1uF bypass capacitor. (Both ceramic capacitors) 2.2μF tantalum capacitors can add better performance.

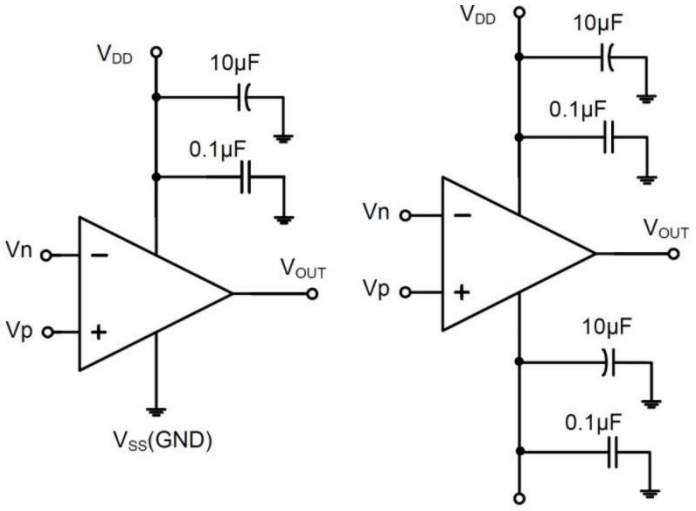



Figure 3, an op amp with a bypass capacitor

## Typical application

### 1. Differential amplifier

As shown in Figure 4, if the resistance is equal, (R4 / R3 = R2 / R1), the output VOUT = (Vp-Vn) × R2 / R1 + VREF.

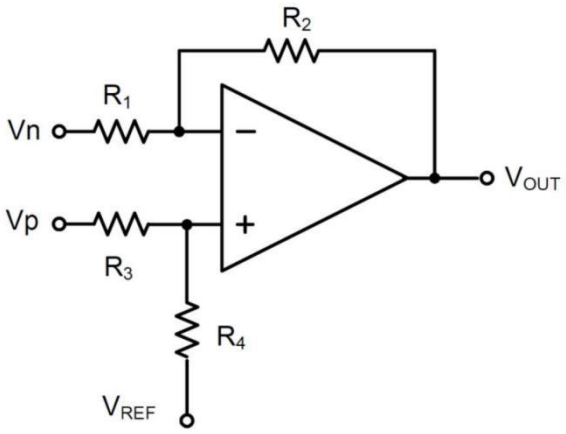



Figure 4, differential amplifier

2. Instrument amplifier

The circuit in Figure 5 has the same function as in Figure 4, but the input is high impedance.

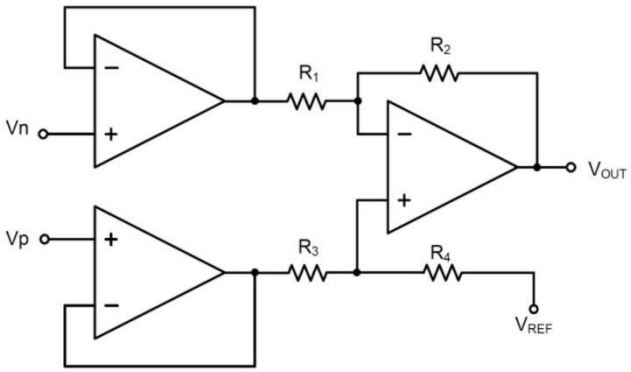



Figure 5, precision amplifier circuit

3. Low-pass active filter

The low-pass filter circuit in Figure 6 has a (-R2 / R1) DC gain and -3dB at a frequency of 1/2πR2C corner. Make sure the filter is within the bandwidth of the amplifier. The resistance with large feedback is easily accompanied by parasitic capacitance at high speed, resulting in adverse effects such as oscillation. Keep the resistance value as low as possible and consider the appropriate output load.

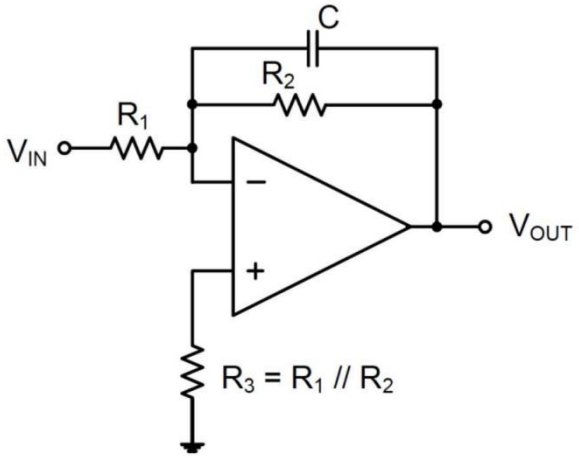
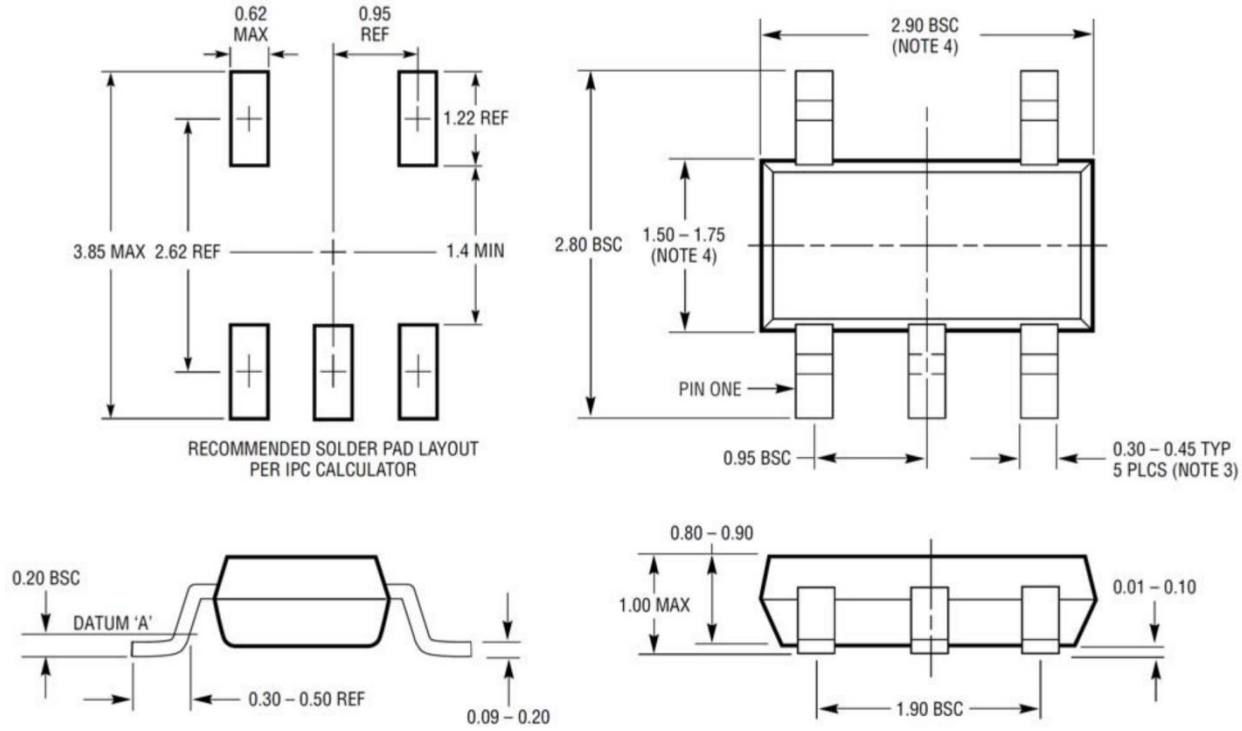



Figure 6, low-pass filter

## Package information (SOT23-5)




NOTE

1. The size is in millimeters;
2. Not drawing to scale
3. This size includes plating
4. This size includes only the bright edge of the plastic mold.