芯伯乐®
XINBOLE

# Product Specification

## XBLW OPA333.2333

High-Precision,Rail-to-Rail I/O Operational Amplifier

WEB | www.xinboleic.com

RoHS

## Description

The OPA333, OPA2333 and are high-precision, low-quiescent current amplifier which can offer high input impedance and rail-to-rail input and output. The amplifier uses auto-zeroing techniques to provide low offset voltage(2μV type) and near zero-drift over time and temperature.These devices are optimized for low-voltage, single-supply operation.

The OPAX333 family provides excellent CMRR with no crossover associated with traditional complementary input levels. The design achieves excellent performance over the drive Analog-to-digital converter (ADC) process without reducing Differential nonlinearity.

The OPA333 (single) is available in SOT23-5 and SOP-8.
The OPA2333 (dual) is available in SOP-8 and MSOP-8.

## Feature:

- Rail-to-RailInputandOutput
- Zero-Dirft:: 0.05μv/℃
- Low Noise: 48nV/√Hz
  0.1Hzto10HzNoise: 0.8μVPP
- Gainbandwidth: 0.4MHz
- Quiescentcurrent: 18μA(Typ.)
- Supply Range: 1.8V-5.5V
- Low Offset Voltage: 2μV(Typ.)

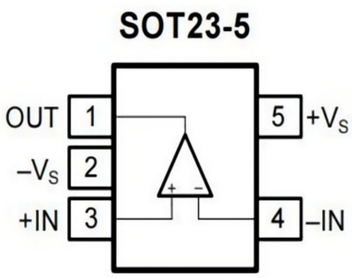
## Applications

- Wearables
- Smartphones
- Electronic Scales
- Circuit Breakers
- Medical Instrumentation
- Battery-Powered Instruments
- Handheld Test Equipment
- Resistance Temperature Detectors

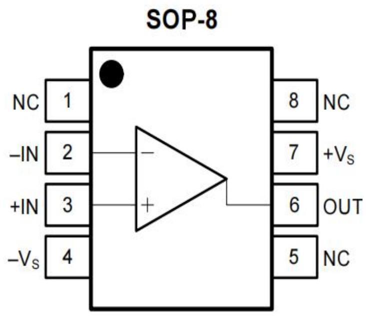
## Ordering Information

| Product Model | Package Type | Marking | Packing | Packing Qty |
|---|---|---|---|---|
| XBLW OPA333AIDBVR | SOT23-5 | 333A | Tape | 3000Pcs/Reel |
| XBLW OPA333AIDR | SOP-8 | O333A | Tape | 2500Pcs/Reel |
| XBLW OPA2333AIDR | SOP-8 | O2333A | Tape | 2500Pcs/Reel |
| XBLW OPA2333AIDGKR | MSOP-8 | 2333A | Tape | 3000Pcs/Reel |
| | | | | |
| | | | | |

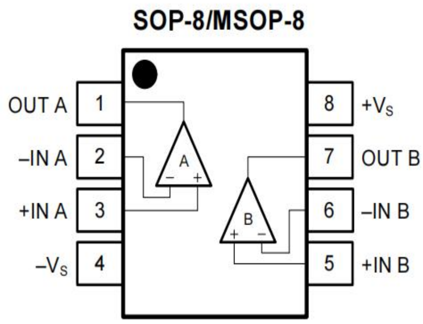
## Pin Configurations




OPA333




OPA333




OPA2333

## Pin Description

| Symbol | Description |
|---|---|
| -INA,-INB | Inverting Input of the Amplifier. The Voltage range can go from (VS–) to (VS+). |
| +INA,+INB | Non-Inverting Input of Amplifier. This pin has the same voltage range as –IN. |
| $+V_S$ | Positive Power Supply. The voltage is from 1.8V to 5.5V（±0.9V to ±2.75V). |
| $-V_S$ | Negative Power Supply. It is normally tied to ground. |
| OUTA,OUTB | Amplifier Output. |
| N/C | No Connection. |

## Absolute Maximum Ratings（TA=25℃)

| Parameter | Description | Value | Units |
|---|---|---|---|
| Supply Voltage | | ±3,+6(Single) | V |
| Voltage | Input Terminal | $V_{S-}$–0.3 to $V_{S+}$0.3 | V |
| Differential Voltage | | ±5 | V |
| Temperature | Operating(2),$T_A$ | -55 to +150 | ℃ |
| | Junction,$T_J$ | 150 | ℃ |
| | Storage,$T_{STG}$ | –65 to +150 | ℃ |
| HBM | Electrostatic Discharge Voltage | 8 | kV |

**Note:**
1.Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2.Provided device does not exceed maximum junction temperature (TJ) at any time.

## Electrical Characteristics

$V_S$=+5.0V,$T_A$=+25°C,$V_{CM}$=$V_S$/2,$V_O$=$V_S$/2,$R_L$=10kΩconnectedto$V_S$/2,unlessotherwisenoted.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| INPUT CHARACTERISTICS | | | | | | |
| $V_{OS}$ | Input offset voltage | | | 2 | 15 | μV |
| $V_{OS}$TC | Offset voltage drif | $T_A$=-40℃to+125℃ | | 0.05 | | μV/°C |
| $I_B$ | Input bias current | $V_{CM}$=$V_S$/2 | | ±100 | | PA |
| $I_{OS}$ | Input offset current | | | ±100 | | PA |
| $V_{CM}$ | Common-mode voltage range | $T_A$=-40℃to+125℃ | $V_{S-}$ | | $V_{S+}$ | V |
| CMRR | Common-mode rejection ratio | $V_{S-}$<$V_{CM}$<$V_{S+}$ | 90 | 110 | | dB |
| | | $T_A$=-40℃to+125℃ | 85 | | | dB |
| $A_{VOL}$ | Open-loop voltage gain | $V_{S-}$+0.3V<$V_O$<$V_{S+}$-0.3V | 105 | 135 | | dB |
| | | $T_A$=-40℃to+125℃ | 100 | | | dB |
| OUTPUT CHARACTERISTICS | | | | | | |
| $V_{OH}$ | High output voltage swing | $R_L$=10KΩ | ($V_{S+}$)-12 | ($V_{S+}$)-4 | | mV |
| | | $T_A$=-40℃to+125℃ | ($V_{S+}$)-18 | | | mV |
| $V_{OL}$ | Low output voltage swing | $R_L$=10KΩ | | ($V_{S-}$)+4 | ($V_{S-}$)+12 | mV |
| | | $T_A$=-40℃to+125℃ | | | ($V_{S-}$)+18 | mV |
| $I_{SC}$ | Short-circuit current | Source current | 55 | 65 | | mA |
| | | $T_A$=-40℃to+125℃ | 50 | | | mA |
| | | Sink current | 48 | 55 | | mA |
| | | $T_A$=-40℃to+125℃ | 45 | | | mA |
| POWERSUPPLY | | | | | | |
| PSRR | Power supply rejection ratio | $V_S$=1.8V to 5.5V | 90 | 110 | | dB |
| | | $T_A$=-40℃to+125℃ | 80 | | | dB |
| $I_Q$ | Quiescent current (per amplifier) | $T_A$=-40℃to+125℃ | | 20 | 28 | μA |
| | | | | | 35 | μA |
| NOISE PERFORMANCE | | | | | | |
| $e_n$ | Input voltage noise density | f=0.1Hzto10Hz | | 800 | | nVpp |
| | | f=1KHz | | 48 | | nV/√Hz |
| DYNAMIC PERFORMANCE | | | | | | |
| GBW | Gain bandwidth productt | | | 0.4 | | MHz |
| SR | Slew rate | G=+1 | | 0.1 | | V/μs |
| $t_{OR}$ | Overload recovery time | G=-10 | | 20 | | μs |

## Electrical Characteristics

$V_S$=+2.7V,$T_A$=+25°C,$V_O$=$V_S$/2,$R_L$=10kΩconnectedto$V_S$/2,unlessotherwisenoted.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| INPUT CHARACTERISTICS | | | | | | |
| $V_{OS}$ | Input offset voltage | | | 4 | 20 | μV |
| $V_{OS}TC$ | Offset voltage drift | $T_A$=-40℃to+125℃ | | 0.05 | | μV/°C |
| $I_B$ | IInput bias current | $V_{CM}$=$V_S$/2 | | ±100 | | PA |
| $I_{OS}$ | Input offset current | | | ±100 | | PA |
| $V_{CM}$ | Common-mode voltage range | $T_A$=-40℃to+125℃ | $V_{S-}$ | | $V_{S+}$ | V |
| CMRR | Common-mode rejection ratio | $V_{S-}$<$V_{CM}$<$V_{S+}$ | 90 | 110 | | dB |
| | | $T_A$=-40℃to+125℃ | 80 | 100 | | |
| $A_{VOL}$ | Open-loop voltage gain | $V_{S-}$+0.3V<$V_O$<$V_{S+}$-0.3V | 105 | 135 | | |
| | | $T_A$=-40℃to+125℃ | 95 | | | |
| OUTPUT CHARACTERISTICS | | | | | | |
| $V_{OH}$ | High output voltage swing | $R_L$=10KΩ | ($V_{S+}$)-12 | ($V_{S+}$)-3 | | mV |
| | | $T_A$=-40℃to+125℃ | ($V_{S+}$)-18 | | | |
| $V_{OL}$ | Low output voltage swing | $R_L$=10KΩ | | ($V_{S-}$)+3 | ($V_{S-}$)+12 | mV |
| | | $T_A$=-40℃to+125℃ | | | ($V_{S-}$)+18 | |
| $I_{SC}$ | Short-circuit current | Source current | 17 | 24 | | mA |
| | | $T_A$=-40℃to+125℃ | 14 | | | mA |
| | | Sink current | 15 | 20 | | mA |
| | | $T_A$=-40℃to+125℃ | 12 | | | mA |
| POWER SUPPLY | | | | | | |
| PSRR | Power supply rejection ratio | $V_S$=1.8V to 5.5V | 90 | 110 | | dB |
| | | $T_A$=-40℃to+125℃ | 80 | | | |
| $I_Q$ | Quiescent current (per amplifier) | $T_A$=-40℃to+125℃ | | 18 | 25 | μA |
| | | | | | 35 | |
| NOISEPE RFORMANCE | | | | | | |
| $e_n$ | Inputvoltagenoisedensity | f=0.1Hzto10Hz | | 800 | | nVpp |
| | | f=1KHz | | 48 | | nV/√Hz |
| DYNAMIC PERFORMANCE | | | | | | |
| GBW | Gain bandwidth product | f=1kHz | | 0.4 | | MHz |
| SR | Slew rate | G=+1 | | 0.1 | | V/μs |
| $t_{OR}$ | Overload recovery time | G=-10 | | 20 | | μs |

## Typical Performance Characteristics

$V_S$=+5V, $T_A$=+25°C, $V_{CM}$=$V_S$/2, $R_L$=10kΩ connected to V/2, unless otherwise noted.

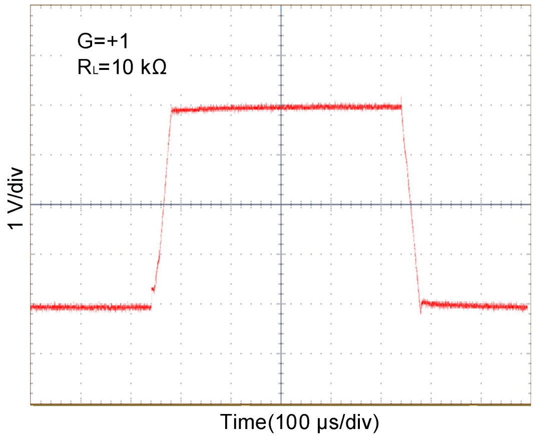



**Figure 2 LARGE-SIGNAL STEP RESPONSE at +5V**

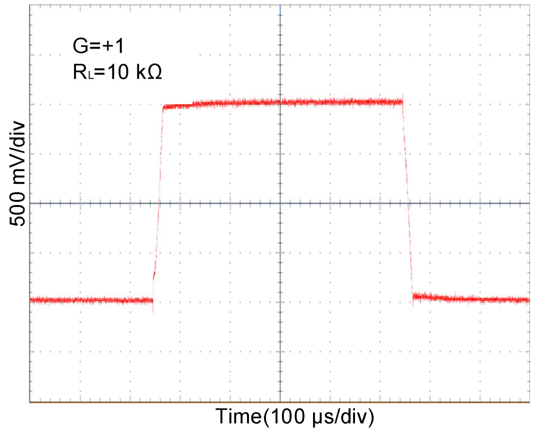



**Figure 3 LARGE-SIGNAL STEP RESPONSE at +2.7V**

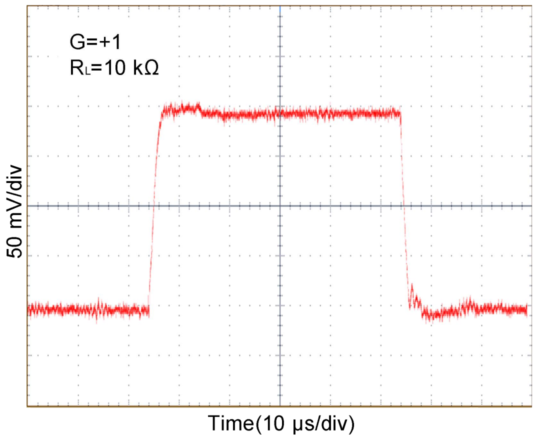



**Figure 4 SMALL-SIGNAL STEP RESPONSE at +5V**

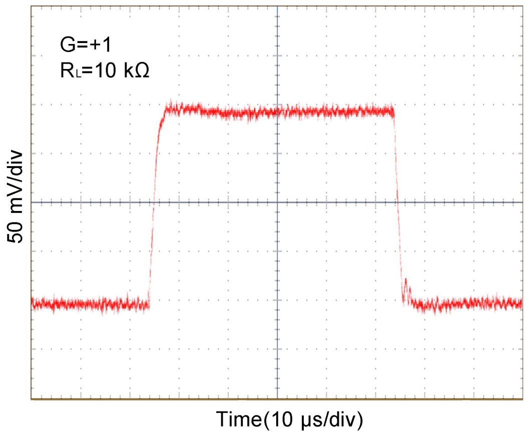



**Figure 5 SMALL-SIGNAL STEP RESPONSE at +2.7V**

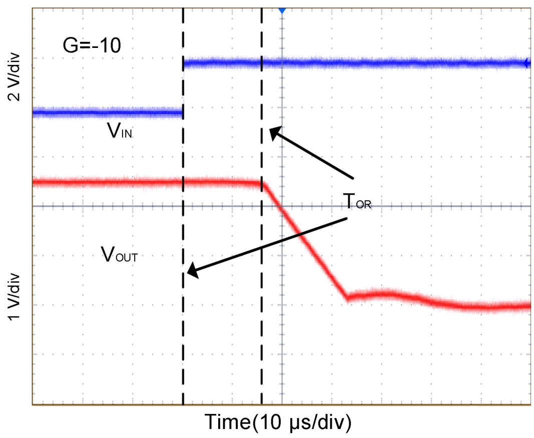



**Figure 6 POSITIVE OVERLOAD RECOVERY**

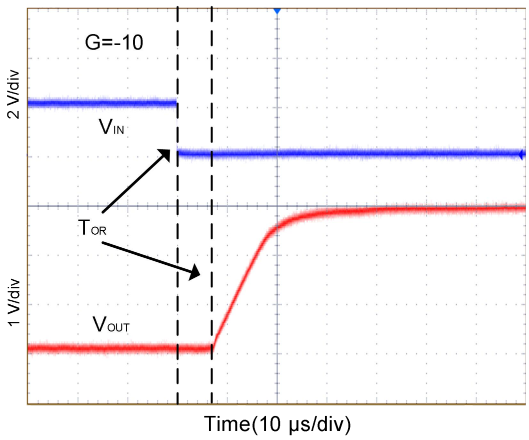



**Figure 7 NEGATIVE OVERLOAD RECOVERY**

## Typical Performance Characteristics

$V_S$=+5V $T_A$=+25°C $V_{CM}$=$V_S$/2 $R_L$=10kΩ connected to V/2 unless otherwise noted

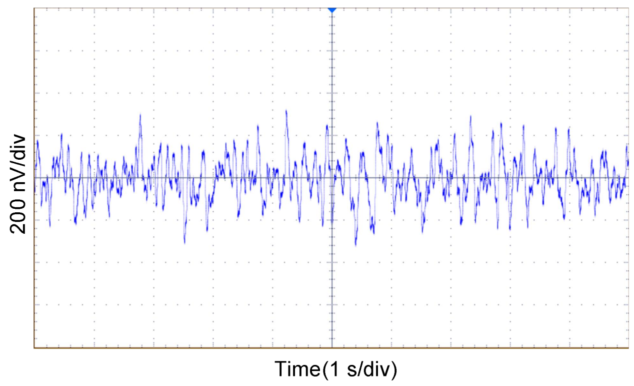



**Figure 8 0.1Hz to 10Hz noise**

# ApplicationNotes

## 1. Operation Characteristics

The OPAX333 is specified for operation from 1.8V to 5.5 V (±0.9V to ±2.75 V). Many specifications apply from –40℃ to +125℃. Parameters that can exhibit significant variance with regard to operating voltage or temperature are presented in *Typical Characteristics.*

## 2. Capacitive Load and Stability

The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive drive capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure 9. The isolation resistor $R_{ISO}$ and the load capacitor $C_L$ form a zero to increase stability. The bigger the $R_{ISO}$ resistor value, the more stable Vout will be. Note that this method results in a loss of gain accuracy because $R_{ISO}$ forms a voltage divider with the $R_L$.

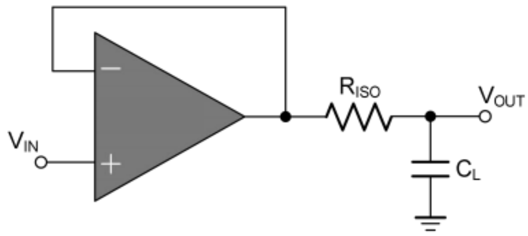



**Figure 9. Indirectly Driving Heavy Capacitive Load**

An improvement circuit is shown in Figure 10. It provides DC accuracy as well as AC stability. The $R_F$ provides the DC accuracy by connecting the inverting signal with the output.

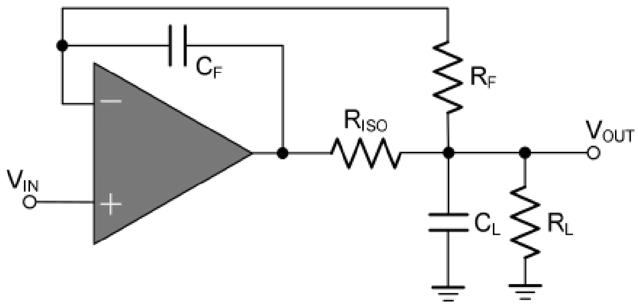



**Figure10.IndirectlyDrivingCapacitiveLoadwithDCAccuracy**

## 3. Input Bias Current Clock Feedthrough

The OPAX333 use switching on the inputs to correct for the intrinsic offset and drift of the amplifier. Charge injection from the integrated switches on the inputs can introduce very short transients in the input bias current of the amplifier. The extremely short duration of these pulses prevents the device from being amplified. However, the devices may be coupled to the output of the amplifier through the feedback network. The most effective method to prevent transients in the input bias current from producing additional noise at the amplifier output is to use a low-pass filter such as an RC network.

## 4. Layout Guidelines

For best operational performance of the device, use good printed circuit board (PCB) layout practices, including:

A.Place the external components as close to the device as possible. This configuration prevents parasitic errors (such as the Seebeck effect) from occurring.

B.To reduce parasitic coupling, run the input traces as far away from the supply lines and digital signal as possible.

C.Low-ESR, 0.1-µF ceramic bypass capacitors must be connected between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable to single supply applications.

D.Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

## 5. Low-side Current Monitor

Figure 11 shows the OPAX333 configured in a low-side current-sensing application.

The load current ($I_{LOAD}$) creates a voltage drop across the shunt resistor ($R_{SHUNT}$). This voltage is amplified by the OPAX333.

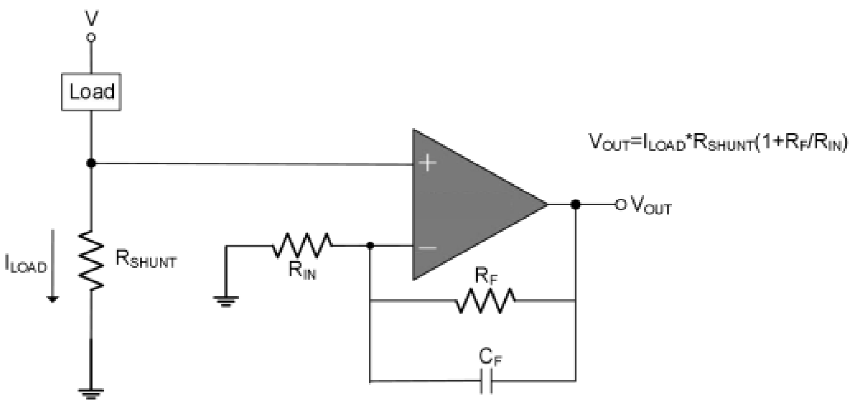



**Figure11.Low-SideCurrentMonitor**

## 6.Bridge Amplifier

Figure 12 shows the basic configuration for a bridge amplifier.

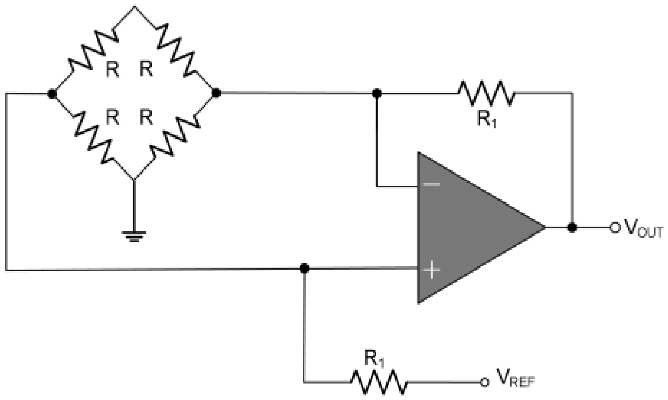



**Figure 12. Bridge Amplifier**

## 7. Programmable Power Supply

Figure 13 shows the OPAX333 configured as a precision programmable power supply using DAC and power amplifier. The OPAX333 in the front-end provides precision and low drift across a wide range of inputs and conditions.

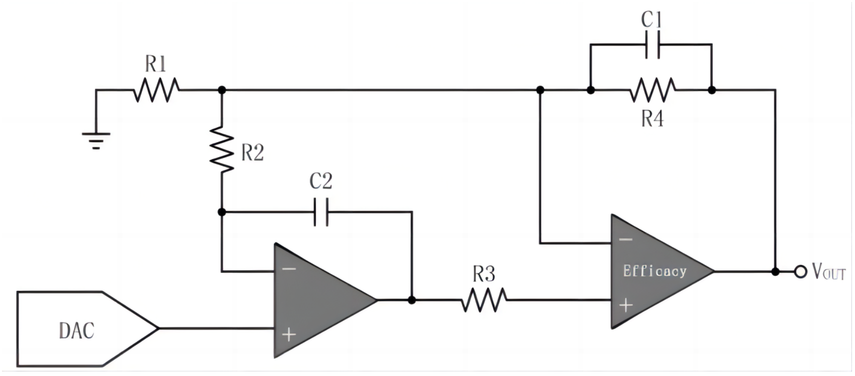
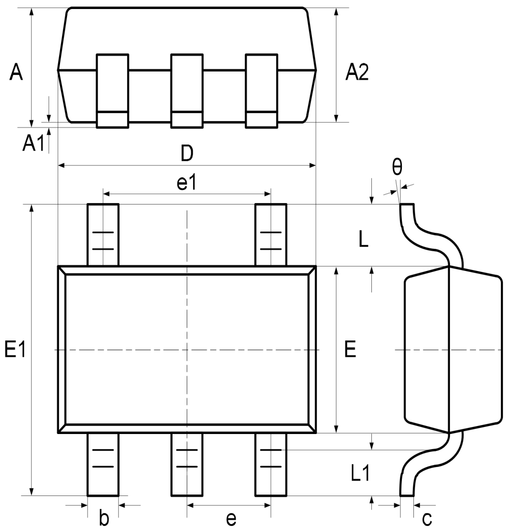



**Figure13.ProgrammablePowerSupply**

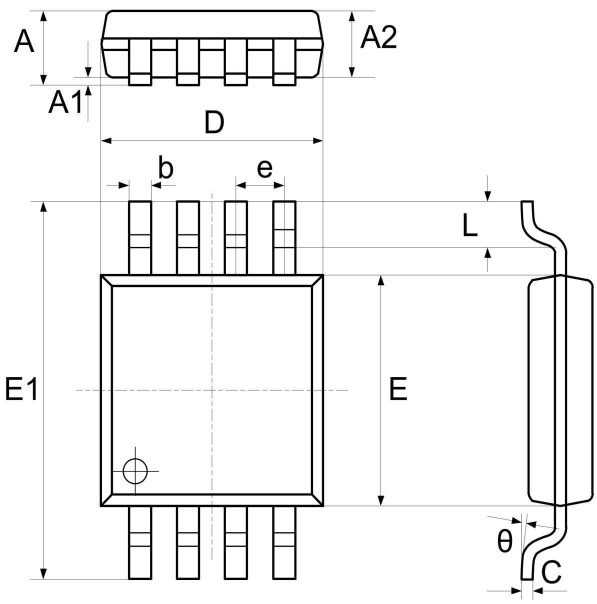
# Package Information

## SOT23-5



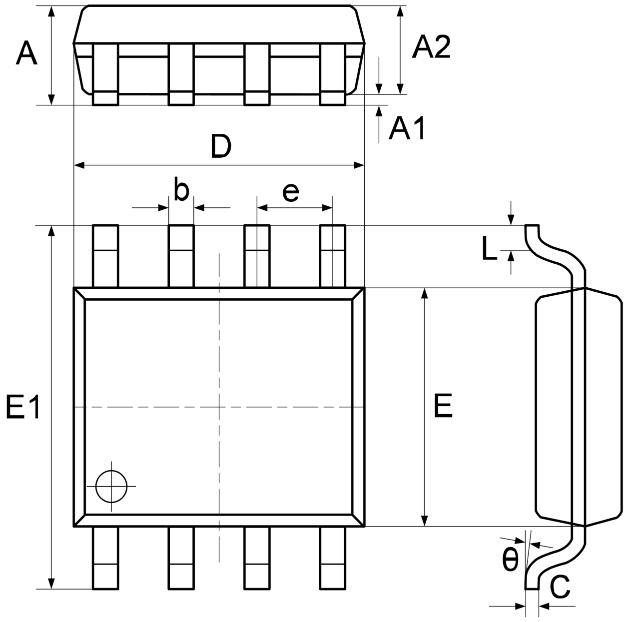

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.040 | 1.350 | 0.042 | 0.055 |
| A1 | 0.040 | 0.150 | 0.002 | 0.006 |
| A2 | 1.000 | 1.200 | 0.041 | 0.049 |
| b | 0.380 | 0.480 | 0.015 | 0.020 |
| c | 0.110 | 0.210 | 0.004 | 0.009 |
| D | 2.720 | 3.120 | 0.111 | 0.127 |
| E | 1.400 | 1.800 | 0.057 | 0.073 |
| E1 | 2.600 | 3.000 | 0.106 | 0.122 |
| e | 0.950 typ. | | 0.037 typ. | |
| e1 | 1.900 typ. | | 0.078 typ. | |
| L | 0.700 ref. | | 0.028 ref. | |
| L1 | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

## MSOP-8




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.800 | 1.100 | 0.033 | 0.045 |
| A1 | 0.050 | 0.150 | 0.002 | 0.006 |
| A2 | 0.750 | 0.950 | 0.031 | 0.039 |
| b | 0.290 | 0.380 | 0.012 | 0.016 |
| C | 0.150 | 0.200 | 0.006 | 0.008 |
| D | 2.900 | 3.100 | 0.118 | 0.127 |
| E | 2.900 | 3.100 | 0.118 | 0.127 |
| E1 | 4.700 | 5.100 | 0.192 | 0.208 |
| e | 0.650 typ. | | 0.026 typ. | |
| L | 0.400 | 0.700 | 0.016 | 0.029 |
| θ | 0° | 8° | 0° | 8° |

**SOP-8**




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.370 | 1.670 | 0.056 | 0.068 |
| A1 | 0.070 | 0.170 | 0.003 | 0.007 |
| A2 | 1.300 | 1.500 | 0.053 | 0.061 |
| b | 0.306 | 0.506 | 0.013 | 0.021 |
| C | 0.203 typ. | | 0.008 typ. | |
| D | 4.700 | 5.100 | 0.192 | 0.208 |
| E | 3.820 | 4.020 | 0.156 | 0.164 |
| E1 | 5.800 | 6.200 | 0.237 | 0.253 |
| e | 1.270 typ. | | 0.050 typ. | |
| L | 0.450 | 0.750 | 0.018 | 0.306 |
| θ | 0° | 8° | 0° | 8° |

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