KTAx333 Series

Zero-Drift, Micro-Power CMOS Operational Amplifiers

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Table of Contents

1 Key Features

- Low offset voltage:
  - $2\ \mu V$ (typical)
  - $10\ \mu V$ (maximum)
- Zero-drift: $0.05\ \mu V/$°C (maximum)
- Micro-power:
  - $17\ \mu A$ (single channel)
  - $30\ \mu A$ (dual channel)
- Rail-to-rail input/output
- Wide supply voltage range: $1.8\ V - 5.5\ V$
- Low 0.1 Hz $-$ 10 Hz noise: $1.1\ \mu V$
- Single-supply operation

2 Typical Applications

- Sensors
- Temperature measurement
- Electronic scales
- Bridge circuit readout
- Medical instruments

3 Overview

The KTAx333 is a single-supply, low-power CMOS operational amplifier capable of rail-to-rail input and output. It employs self-calibration technology to achieve an extremely low offset voltage ($2\ \mu V$, typical) with nearly zero drift over temperature and time. The amplifier offers high input impedance (common-mode range exceeding the supply rail voltage by $100\ mV$) and can operate with a single supply from $1.8\ V\ (\pm 0.9\ V)$ up to $5.5\ V\ (\pm 2.75\ V)$, or with dual supplies.

The KTAx333 series delivers excellent common-mode rejection ratio (CMRR) performance without the crossover distortion associated with traditional complementary input stages. This design enables outstanding performance when driving analog-to-digital converters (ADCs) without sacrificing differential linearity.

The KTA333 (single-channel) is available in 5-pin SOT-23-5, SC70-5, and SOP-8 packages. The KTA2333 (dual-channel version) is available in SOP-8, MSOP-8, and DFN-2×2-8 packages.

4 Pin Configuration and Functions

4.1 KTA333 Pin Functions

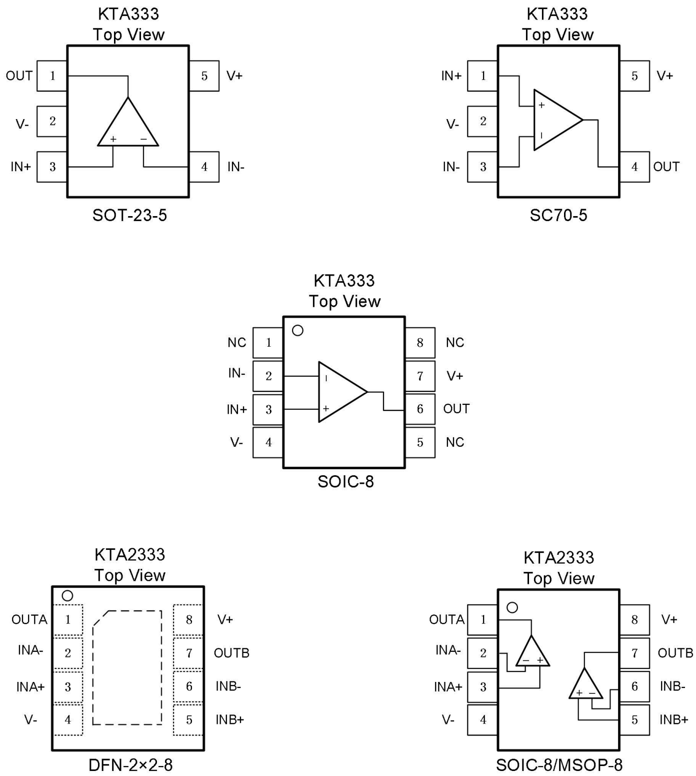


Figure 1: KTAx333 Package and Pin Functions

Pin Name	Pin of SOP	Pin of SOT	Pin of SC70	I/O	Description
IN+	3	3	1	I	Non-inverting input
IN−	2	4	3	I	Inverting input
NC	1, 5, 8	—	—	—	No connection (can be left floating)
OUT	6	1	4	O	Output
V+	7	5	5	—	Positive power supply
V−	4	2	2	—	Negative power supply

Table 1: KTA333 Pin Configuration

4.2 KTA2333 Pin Functions

Pin Name	Pin of DFN	Pin of SOP/MSOP	I/O	Description
INA+	3	3	I	Non-inverting input, channel A
INA-	2	2	I	Inverting input, channel A
INB+	5	5	I	Non-inverting input, channel B
INB-	6	6	I	Inverting input, channel B
OUTA	1	1	O	Output, channel A
OUTB	7	7	O	Output, channel B
V+	8	8	—	Positive power supply
V-	4	4	—	Negative power supply

Table 2: KTA2333 Pin Configuration

4.3 KTAx333 Series Part Name Definition

KTAX333-XXX

Package: ST5: SOT23-5
SF5: SOT353-5
SC5: SC70-5
SP8: SOP-8
MP8: MSOP-8
DZ8: DFN2020-8
SC8: SOIC-8

Channel: Blank: Single
2: Dual

Figure 2: KTAx333 Part Name Definition

5 Specifications

5.1 Absolute Maximum Ratings

Parameter	Min	Max
Supply Voltage V_{CC}	$6.5\ V$	
Input Voltage V_{IN}	V^--0.2V	V^++0.2V
Junction Temperature T_J		150 °C
Storage Temperature T_{STG}	-65 °C	150 °C

Table 3: Absolute Maximum Ratings

Note: Exceeding the absolute maximum ratings 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 operational sections of this specification is not implied. Prolonged operation at the maximum absolute rating conditions may affect device reliability.

5.2 ESD Ratings

Parameter	Value
Human Body Model (HBM)	7 kV

Table 4: ESD Ratings

5.3 Recommended Operating Conditions

Parameter	Min	Max
Supply Voltage V_{CC}	$1.8\ V$	$5.5\ V$
Operating Temperature Range T_A	-40 °C	125 °C

Table 5: Recommended Operating Conditions

6 Electrical Characteristics

Conditions: @T_A=+25°C, V_{CM}=Vs/2, VOUT=Vs/2, unless otherwise noted.

6.1 Input Characteristics

Parameter Name	Description	Conditions	Min	Typ	Max	Unit
V_{OS}	Offset Voltage	$V_S = 5\ V$		2	10	μV
dV_{OS}/dT	Offset Voltage Drift	$T_A = -40$°C to 125°C		0.02	0.05	$\mu V/$°C
I_B	Input Bias Current			±100		pA
I_{OS}	Input Offset Current			±120		pA
V_{CM}	Common Mode Voltage Range		$(V^-) - 0.1$		$(V^+) + 0.1$	V
$CMRR$	Common Mode Rejection Ratio	$(V^-) - 0.1\ V < V_{CM} < (V^+) + 0.1\ V$, $T_A = -40$°C to 125°C		120		dB
A_{OL}	Open-Loop Voltage Gain	$(V^-) + 100mV < V_O < (V^+) - 100mV$, $R_L = 10\ k\Omega$, $T_A = -40$°C to 125°C		120		dB

Table 6: Input Characteristics

6.2 Output Characteristics

Parameter Name	Description	Conditions	Min	Typ	Max	Unit
Output Swing relative to Power Rails		$R_L = 10$ kΩ		30	70	mV
I_{SC}	Short-Circuit Current			± 17		mA

Table 7: Output Characteristics

6.3 Power Supply

Parameter Name	Description	Conditions	Min	Typ	Max	Unit
V_S	Supply Voltage Range		1.8		5.5	V
I_Q	Quiescent Current (Single)	$I_O = 0\ A$, $T_A = -40°C$ to $125°C$, signle amplier		17		μA
I_Q	Quiescent Current (Dual)	$I_O = 0\ A$, $T_A = -40°C$ to $125°C$, dual ampliers		30		μA
$PSRR$	Power Supply Rejection Ratio	$V_S = 1.8\ V$ to $5.5\ V$, $T_A = -40°C$ to $125°C$		1	5	$\mu V/V$
Turn-on Time		$V_S = 5V$		200		μs

Table 8: Power Supply Characteristics

6.4 Frequency Characteristics

Parameter Name	Description	Conditions	Min	Typ	Max	Unit
GBW	Gain Bandwidth Product	$C_L = 100\ pF$		350		kHz
SR	Slew Rate	$G = 1$		0.16		$V/\mu s$

Table 9: Frequency Characteristics

6.5 Noise Characteristics

Parameter Name	Description	Conditions	Min	Typ	Max	Unit
Input Noise		$f = 0.1$ Hz to 10 Hz		1.1		μV_{PP}

Table 10: Noise Characteristics

6.6 Temperature Characteristics

Parameter Name	Description	Conditions	Min	Typ	Max	Unit
T_A	Operating Temperature Range		-40		125	°C

Table 11: Temperature Characteristics

7 Typical Characteristics

(@$T_A = +25°$C, $V_S = 5$V, $C_L = 0$pF, unless otherwise noted.)

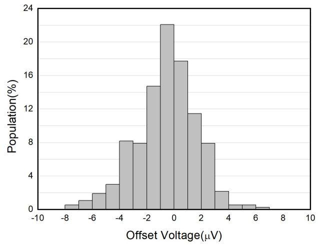


Figure 3: Offset Voltage Distribution

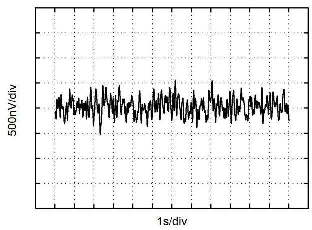


Figure 4: 0.1Hz to 10Hz Noise

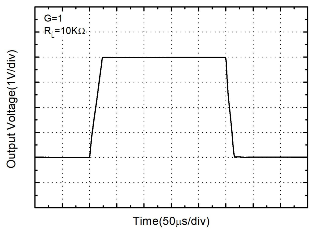


Figure 5: Large Signal Step Response

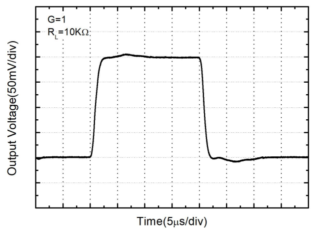


Figure 6: Small Signal Step Response

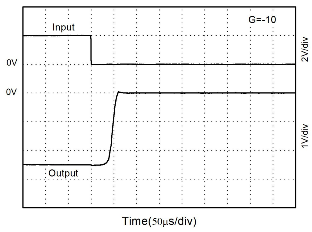


Figure 7: Negative Overvoltage Recovery

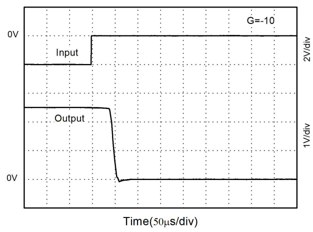


Figure 8: Positive Overvoltage Recovery

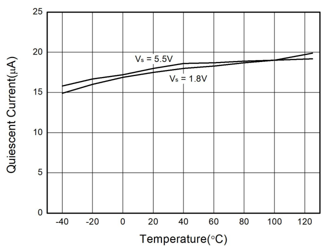


Figure 9: Quiescent Current vs. Temperature

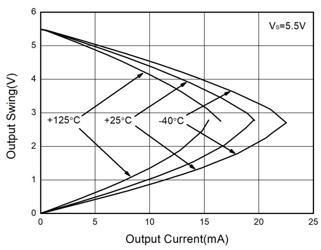


Figure 10: Output Voltage Swing vs. Output Current

8 Application Guide

The KTAx333 series operational amplifiers feature unity-gain stability and are suitable for a wide range of general-purpose applications. They offer very low offset voltage with minimal drift over time and temperature variations.

8.1 Operating Voltage

The KTAx333 series operational amplifiers can operate with a single supply voltage ranging from $1.8\ V$ to $5.5\ V$, or a dual supply ranging from $\pm 0.9\ V$ to $\pm 2.75\ V$. Operating beyond the absolute maximum voltage of $6.5\ V$ can permanently damage the device. To achieve better performance, a 0.1 μF bypass capacitor should be placed near the power supply pins.

8.2 Rail-to-Rail Input/Output

The KTAx333 series features rail-to-rail input and output capabilities, providing a wide input common-mode voltage range that exceeds the supply voltage by $100\ mV$. The output swing can achieve within $100\ mV$ of the supply rails under a $10\ k\Omega$ load.

8.3 Input Protection

The KTAx333 series includes internal ESD protection diodes connected between the input pins and the supply rails, as shown in Figure 11. These diodes conduct when the input voltage exceeds either supply rail by 300 mV, providing over-voltage protection. However, if the current flowing through the diodes exceeds 10 mA, the device may be permanently damaged. To prevent this, an input resistor can be used, as shown in Figure 12.

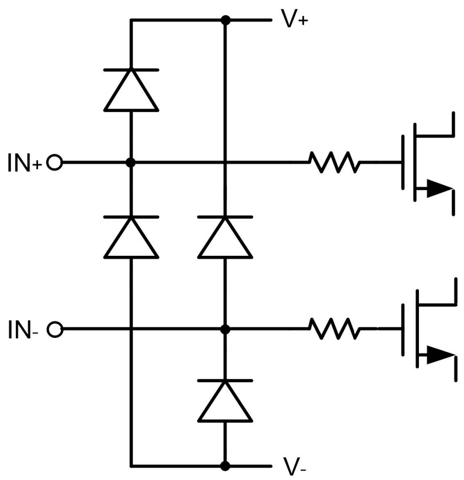


Figure 11: Input ESD Protection Structure

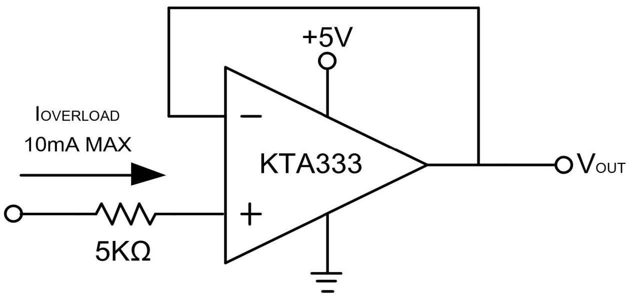


Figure 12: Input Current Protection

8.4 Internal Offset Correction

The KTAx333 series operational amplifiers use a chopper stabilization technique combined with a continuous-time signal chain. This amplifier performs offset correction every $10\ \mu s$, and after power-on, it requires approximately $200\ \mu s$ to reach the specified offset accuracy. The use of chopper stabilization also eliminates 1/f noise.

8.5 Residual Ripple

The KTAx333 series operational amplifiers use chopper-stabilization technology to eliminate offset voltage, while a notch filter is employed to suppress ripple caused by the chopper modulation. Although the ripple voltage is reduced, significant residual noise energy remains at the chopper frequency and its harmonics. To further attenuate noise at the chopper frequency, it is recommended to add a post-filter at the output of the operational amplifier.

9 Typical Applications

9.1 Temperature Measurement

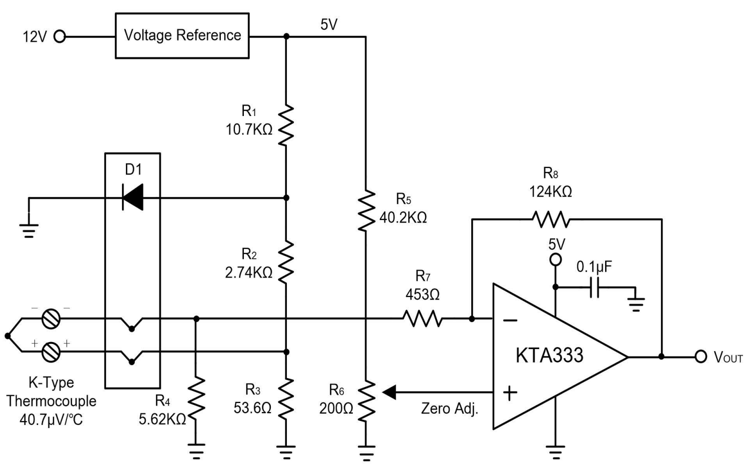


Figure 13: Temperature Measurement Application

9.2 Thermistor Measurement

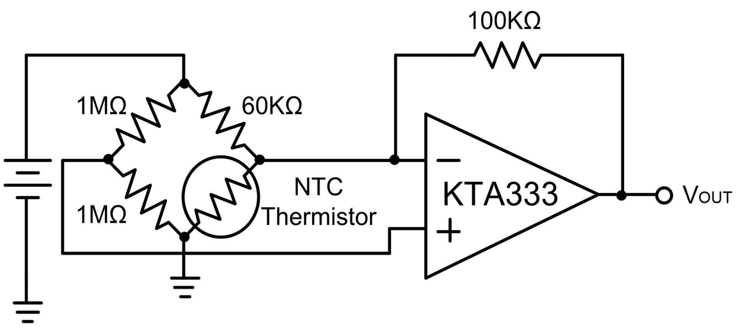


Figure 14: Thermistor Measurement Application

9.3 Low-Side Current Monitoring

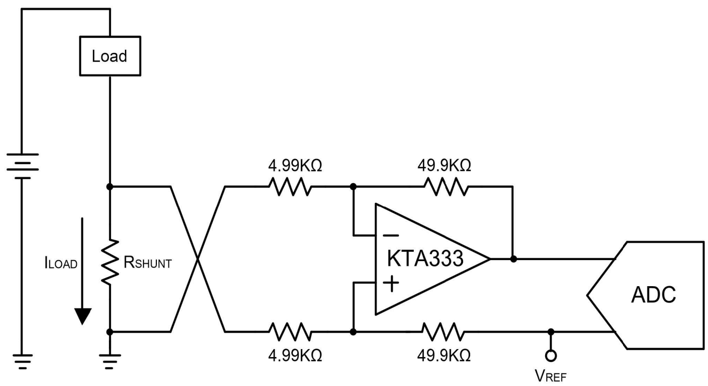
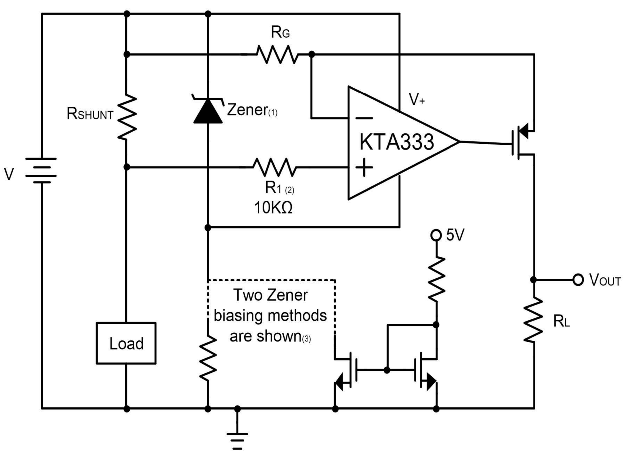


Figure 15: Low-Side Current Monitoring

9.4 High-Side Current Monitoring



NOTES:(1)Zener rated for op amp supply capability(that is 5.1V for KTA333).
(2)Current-limiting resistor.
(3)Chhose Zener biasing resistor or dual NMOSFETs

Figure 16: High-Side Current Monitoring

9.5 Instrumentation Amplifier

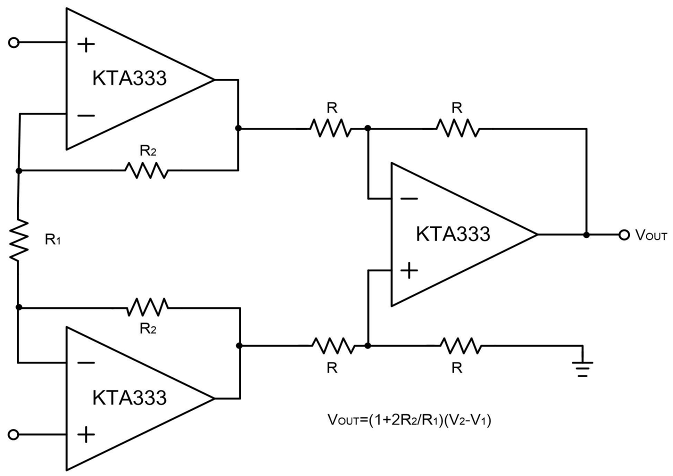


Figure 17: Instrumentation Amplifier Application

10 Ordering Information

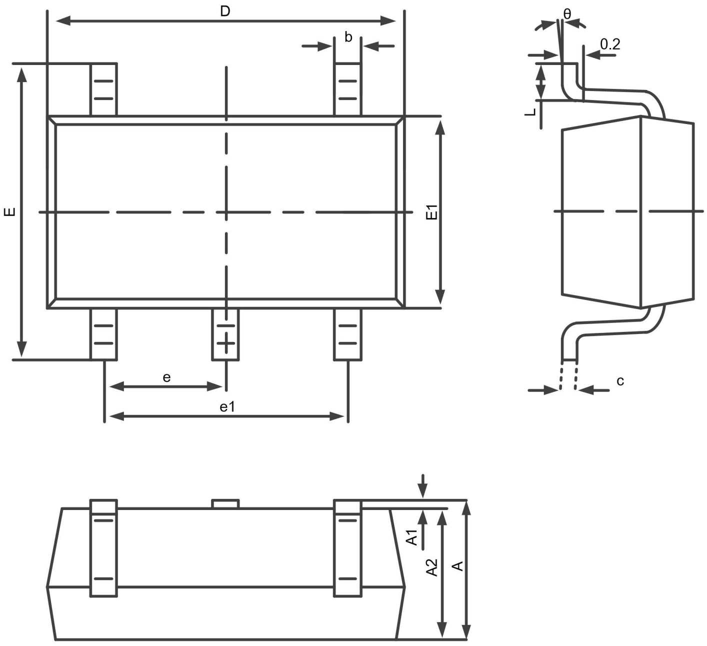
Model	Package Type	Pin Count	Standard Package Quantity	Temperature Range
KTA333-ST5	SOT23-5	5	3000	-40°Cto125°C
KTA2333-MP8	MSOP-8	8	4000	-40°Cto125°C
KTA333-SF5*	SOT353-5	5	—	-40°Cto125°C
KTA333-SC5*	SC70-5	5	—	-40°Cto125°C
KTA333-SP8*	SOP-8	8	—	-40°Cto125°C
KTA2333-DZ8*	DFN-2×2-8	8	—	-40°Cto125°C
KTA2333-SP8	SOP-8	8	4000	-40°Cto125°C

Table 12: Ordering Information for KTAx333 Series

Note:Models marked with *are currently available only as sample quantities and not for mass production.

11 Package Dimensions

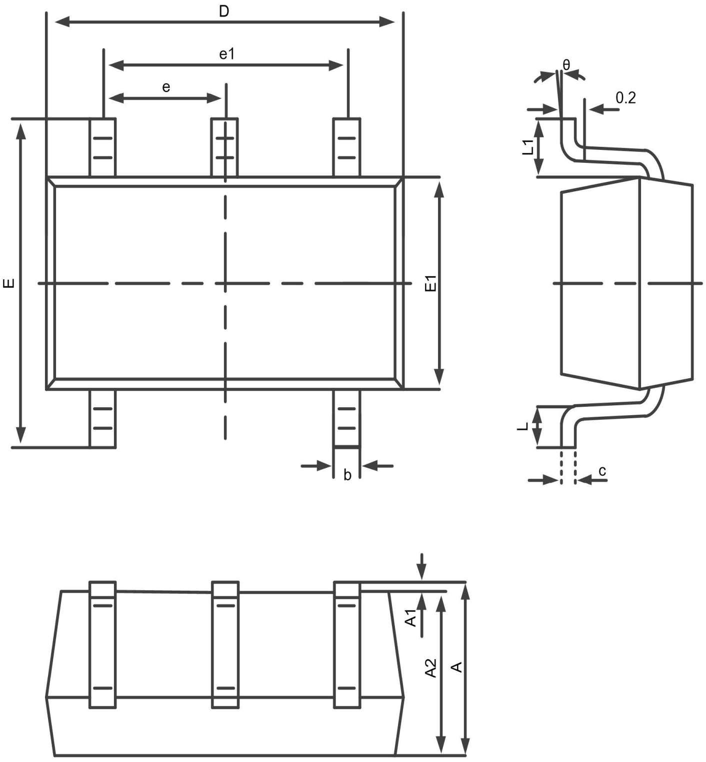
11.1 SOT23-5



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	2.650	2.950	0.104	0.116
E1	1.500	1.700	0.059	0.067
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Table 13: SOT23-5 Package Dimensions

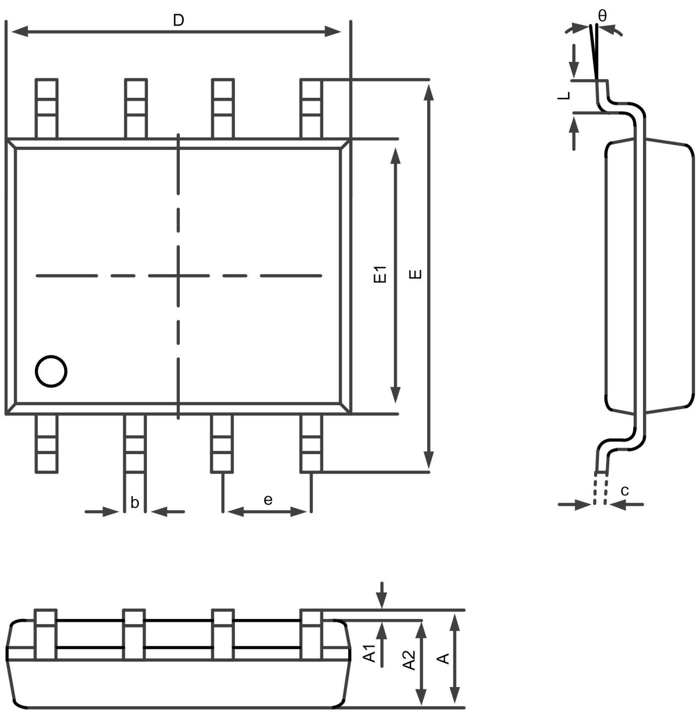
11.2 SC70-5 (SOT353)



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.110	0.175	0.004	0.007
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650(TYP)		0.026(TYP)	
e1	1.200	1.400	0.047	0.055
L	0.300	0.600	0.012	0.024
L1	0.525(REF)		0.021(REF)	
θ	$0°$	$8°$	$0°$	$8°$

Table 14: SC70-5 Package Dimensions

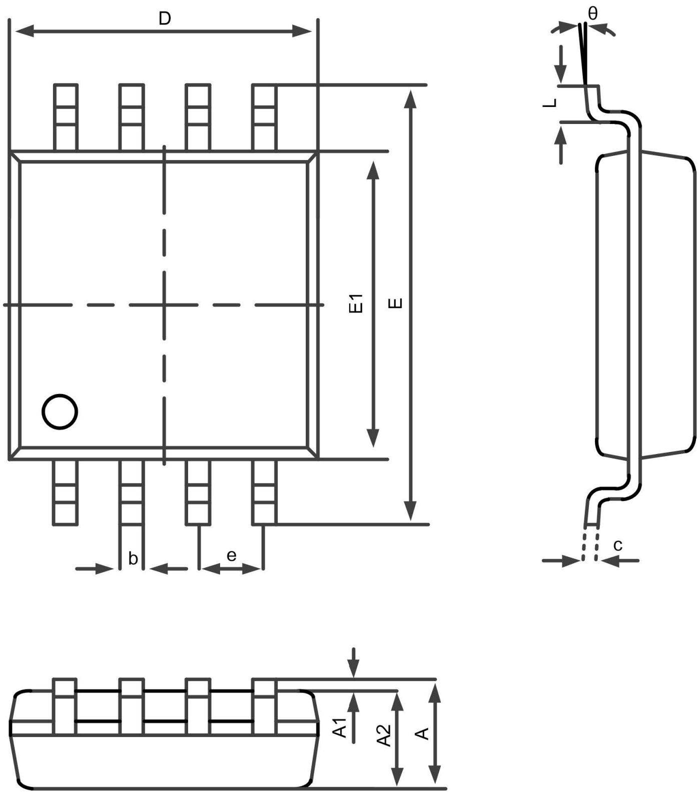
11.3 SOP-8



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270(TYP)		0.050(TYP)	
L	0.400	0.800	0.016	0.031
θ	$0°$	$8°$	$0°$	$8°$

Table 15: SOP-8 Package Dimensions

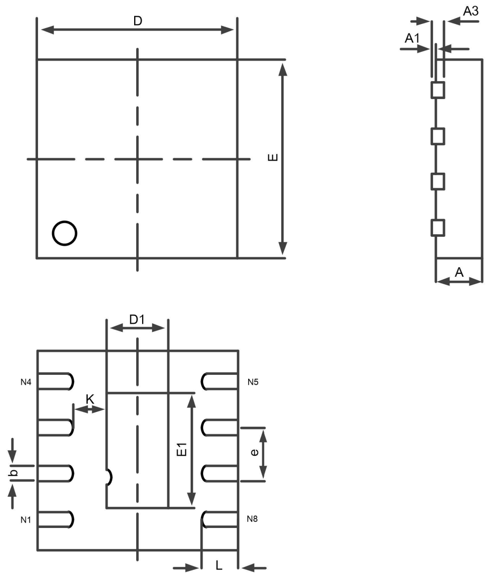
11.4 MSOP-8



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.750	5.050	0.187	0.199
E1	2.900	3.100	0.114	0.122
e	0.650(TYP)		0.026(TYP)	
L	0.400	0.800	0.016	0.031
θ	$0°$	$6°$	$0°$	$6°$

Table 16: MSOP-8 Package Dimensions

11.5 DFN-2×2-8



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203(REF)		0.008(REF)	
D	1.900	2.100	0.075	0.083
E	1.900	2.100	0.075	0.083
D1	0.500	0.700	0.020	0.028
E1	1.100	1.300	0.043	0.051
K	0.350(REF)		0.014(REF)	
b	0.200	0.300	0.008	0.012
e	0.500(BSC)		0.020(BSC)	
L	0.274	0.426	0.011	0.017

Table 17: DFN-2×2-8 Package Dimensions