1.1MHz, Precision, Rail-to-Rail I/O CMOS Operational Amplifier

1 Features

- **High Gain Bandwidth:1.1MHz**
- **Rail-to-Rail Input and Output**
- **±0.5mV Max Vos (ZM6331P, ZM6332P)**
  ±0.8mV Max Vos (ZM6334P)
- **Input Voltage Range: -0.1V to +5.6V with Vs = 5.5V**
- **Supply Range: +2.1V to +5.5V**
- **Supply Range +125°C**
- **Micro Size Packages: SOT23-5, SOT353(SC70-5)**

2 Applications

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

3 Descriptions

The ZM6331P, ZM6332P, ZM6334P families of products offer 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 ZM6331P, ZM6332P and ZM6334P has lower offset, which is guaranteed not upper than ±0.5mV (ZM6331P, ZM6332P) / ±0.8mV (ZM6334P) at 25°C with Vs = 5V, V_{CM} = Vs/2.

The devices are ideal for sensor interfaces, active filters and portable applications. The ZM6331P, ZM6332P, ZM6334P families of operational amplifiers are specified at the full temperature range of −40°C to +125°C under single supplies of 2.1V to 5.5V or dual power supplies of ±1.05V to ±2.75V.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
ZM6331P	SOT23-5	2.90mm×1.60mm
	SOT353(SC70-5)	2.10mm×1.25mm
ZM6332P	SOIC-8(SOP8)	4.90mm×3.90mm
	MSOP-8	3.00mm×3.00mm
ZM6334P	SOIC-14(SOP14)	8.65mm×3.90mm
	TSSOP-14	5.00mm×4.40mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Table of Contents

4 Revision History

Note: Page numbers for previous revisions may different from page numbers in the current version.

VERSION	Change Date	Change Item
A.1	2022/05/17	Initial version completed

5 Package/Ordering Information(1)

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking(2)	MSL(3)	Package Qty
ZM6331PXF	SOT23-5	5	1	-40°C ~125°C	6331P	MSL3	Tape and Reel,3000
ZM6331PXC5	SOT353(SC70-5)	5	1	-40°C ~125°C	6331P	MSL3	Tape and Reel,3000
ZM6331BPXF	SOT23-5	5	1	-40°C ~125°C	6331BP	MSL3	Tape and Reel,3000
ZM6331BPXC5	SOT353(SC70-5)	5	1	-40°C ~125°C	6331BP	MSL3	Tape and Reel,3000
ZM6332PXK	SOIC-8(SOP8)	8	2	-40°C ~125°C	ZM6332P	MSL3	Tape and Reel,4000
ZM6332PXM	MSOP-8	8	2	-40°C ~125°C	ZM6332P	MSL3	Tape and Reel,4000
ZM6334PXP	SOIC-14(SOP14)	14	4	-40°C ~125°C	ZM6334P	MSL3	Tape and Reel,4000
ZM6334PXQ	TSSOP-14	14	4	-40°C ~125°C	ZM6334P	MSL3	Tape and Reel,4000

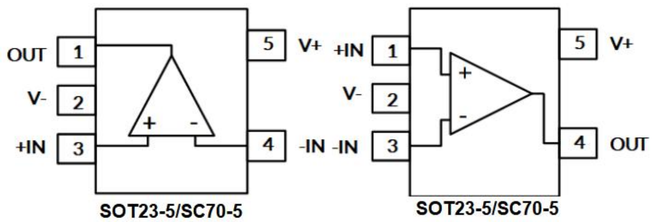
NOTE:

(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(2) There may be additional marking, which relates to the lot trace code information (data code and vendor code), the logo or the environmental category on the device.

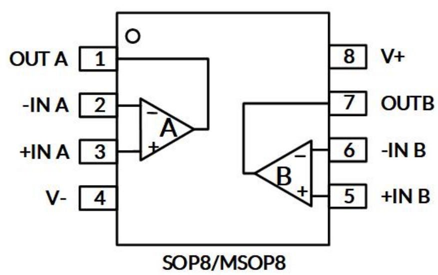
(3) MSL, The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications.

6 Pin Configuration and Functions (Top View)



Pin Description

NAME	PIN		I/O	DESCRIPTION
	ZM6331P	ZM6331BP		
	SOT23-5/SOT353 (SC70-5)	SOT23-5/SOT353 (SC70-5)		
-IN	4	3	I	Negative (inverting) input
+IN	3	1	I	Positive (noninverting) input
OUT	1	4	O	Output
V-	2	2	-	Negative (lowest) power supply
V+	5	5	-	Positive (highest) power supply

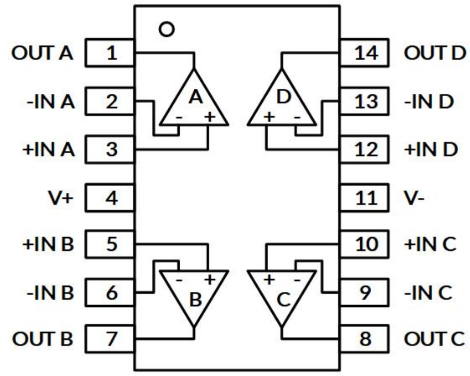


Pin Description

NAME	PIN	I/O	DESCRIPTION
	SOIC-8(SOP8)/MSOP8		
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	5	I	Noninverting input, channel B
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
V-	4	-	Negative (lowest) power supply
V+	8	-	Positive (highest) power supply

Pin Configuration and Functions (Top View)

ZM6334



SOP14,TSSOP14

Pin Description

NAME	PIN	I/O	DESCRIPTION
	SOIC-14(SOP14)/TSSOP-14		
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	5	I	Noninverting input, channel B
-INC	9	I	Inverting input, channel C
+INC	10	I	Noninverting input, channel C
-IND	13	I	Inverting input, channel D
+IND	12	I	Noninverting input, channel D
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
OUTC	8	O	Output, channel C
OUTD	14	O	Output, channel D
V-	11	-	Negative (lowest) power supply
V+	4	-	Positive (highest) power supply

7 Specifications

7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

		MIN	MAX	UNIT
Voltage	Supply, Vs=(V+) - (V-)		7	V
	Signal input pin (2)	(V-)-0.5	(V+) +0.5	
	Signal output pin (3)	(V-)-0.5	(V+) +0.5	
Current	Signal input pin (2)	-10	10	mA
	Signal output pin (3)	-140	140	mA
	Output short-circuit (4)	Continuous		
Temperature	Operating range, T_A	-40	125	°C
	Junction, T_J	-40	150	
	Storage, T_{stg}	-65	150	

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) 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.
(3) 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 ±140mA or less.
(4) Short-circuit to ground, one amplifier per package.

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM)	±3000	V
		Machine Model (MM)	±200	

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
Supply voltage, Vs= (V+) - (V-)	Signal-supply	2.1		5.5	V
	Dual-supply	±1.05		±2.75	

7.4 Electrical Characteristics

(At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.)

PARAMETER		CONDITIONS	T_J	ZM6331P, ZM6332P, ZM6334P			
				MIN	TYP	MAX	UNIT
POWER SUPPLY							
Vs	Operating Voltage Range		25°C	2.1		5.5	V
I_Q	Quiescent Current/Amplifier		25°C		85	145	μA
PSRR	Power-Supply Rejection Ratio	Vs=2.1V to 5.5V, V_{CM}=(V-)+0.5V	25°C	75	92		dB
			-40°C to 125°C	65			
t_{ON}	Turn-on time	Vs= 5V			20		μs
INPUT							
V_{OS}	Input Offset Voltage	ZM6331P	25°C	-0.5	±0.2	0.5	mV
		ZM6332P	25°C	-0.5	±0.2	0.5	
		ZM6334P	25°C	-0.8	±0.3	0.8	
$V_{OS}T_C$	Input Offset Voltage Average Drift		-40°C to 125°C		±2		μV/°C
IB	Input Bias Current		25°C		±10	±50	pA
Ios	Input Offset Current		25°C		±10	±50	pA
V_{CM}	Common-Mode Voltage Range	Vs= 5.5V	25°C	-0.1		5.6	V
CMRR	Common-Mode Rejection Ratio	Vs= 5.5V, V_{CM} =-0.1V to 4V	25°C	75	95		dB
			-40°C to 125°C	68			
		Vs= 5.5V, V_{CM} =-0.1V to 5.6V	25°C	63	85		
			-40°C to 125°C	57			
OUTPUT							
A_{OL}	Open-Loop Voltage Gain	R_L=2KΩ, Vo= 0.15V to 4.85V	25°C	95	110		dB
			-40°C to 125°C	85			
		R_L=10KΩ, Vo= 0.05V to 4.95V	25°C	100	120		
			-40°C to 125°C	92			
	Output Swing From Rail	R_L=2KΩ	25°C		25		mV
		R_L=10KΩ			8		
I_{OUT}	Output Current Source		25°C		120		mA
FREQUENCY RESPONSE							
SR	Slew Rate		25°C		0.5		V/μs
GBP	Gain-Bandwidth Product		25°C		1.1		MHz
PM	Phase Margin		25°C		64		°
ts	Setting Time,0.1%				1.3		μs
	Overload Recovery Time	V_{IN} Gain≥V_S			4.7		μs
NOISE							
e_n	Input Voltage Noise Density	f = 1KHz	25°C		22		nV/√Hz
		f = 10KHz	25°C		20		nV/√Hz

(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.
(2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.
(4) This parameter is ensured by design and/or characterization and is not tested in production.
(5) Positive current corresponds to current flowing into the device.

(6) The maximum power dissipation is a function of TJ(MAX), RθJA, and TA. The maximum allowable power dissipation at any ambient temperature is PD = (T J(MAX) - TA) / RθJA. All numbers apply for packages soldered directly onto a PCB.
(7) Short circuit test is a momentary test.
(8) Number specified is the slower of positive and negative slew rates.
(9) Specified by characterization only.

7.5 Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

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

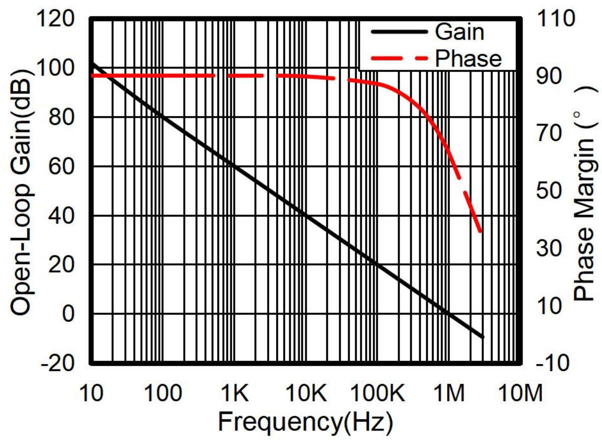


Figure 1. Open-Loop Gain and Phase vs Frequency

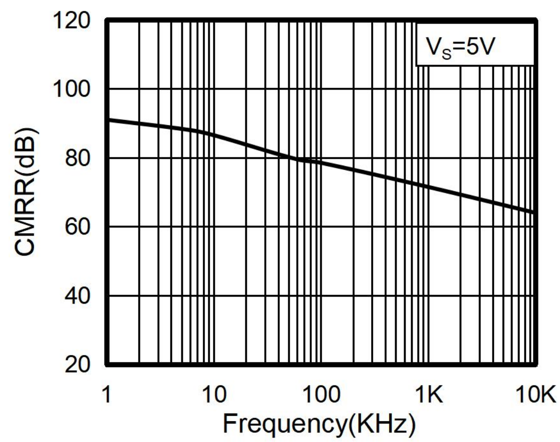


Figure 2. Common-Mode Rejection Ratio vs Frequency

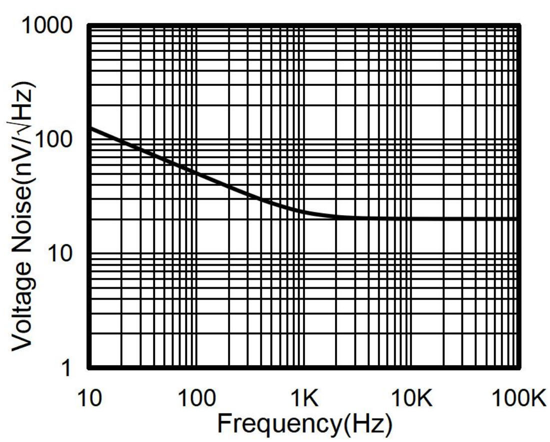


Figure 3. Input Voltage Noise Spectral Density vs Frequency

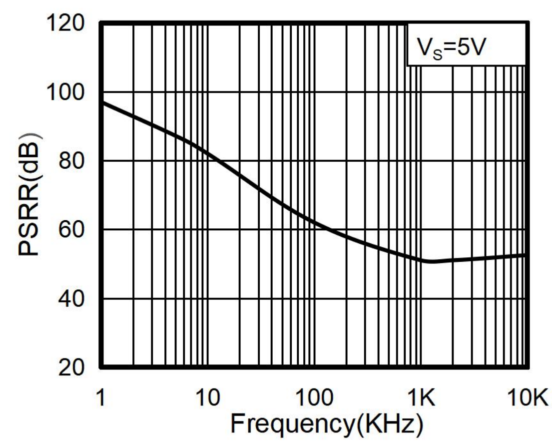


Figure 4. Power-Supply Rejection Ratio vs Frequency

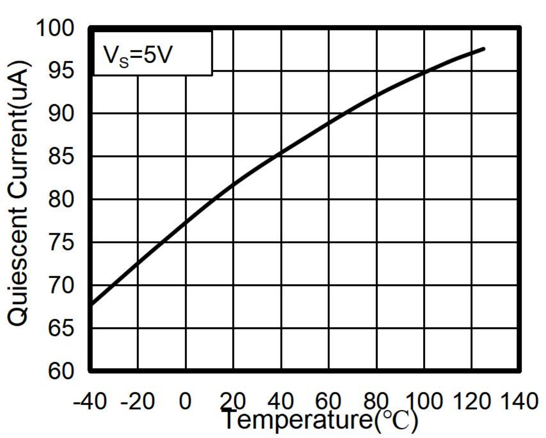


Figure 5. Quiescent Current vs Temperature

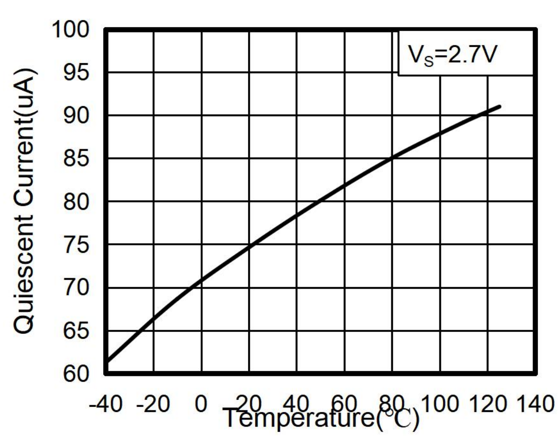


Figure 6. Quiescent Current vs Temperature

Typical Characteristics

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

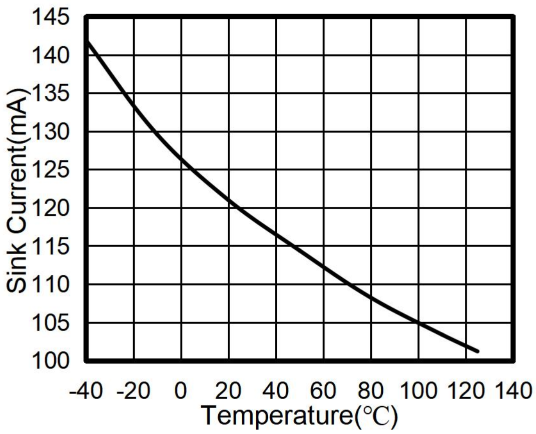


Figure 7. Sink Current vs Temperature

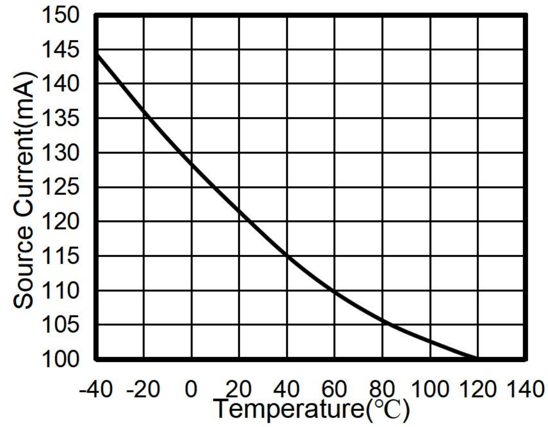


Figure 8. Source Current vs Temperature

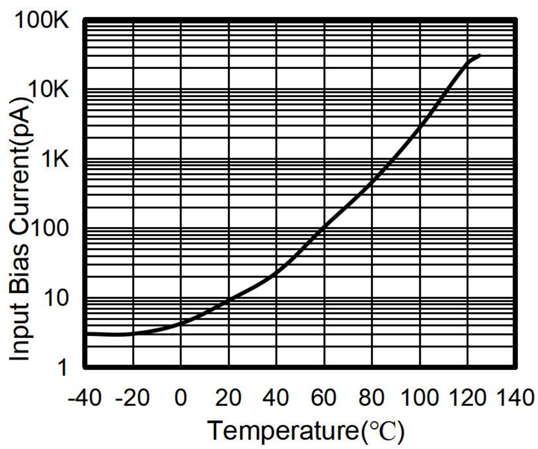


Figure 9. Input Bias Current vs Temperature

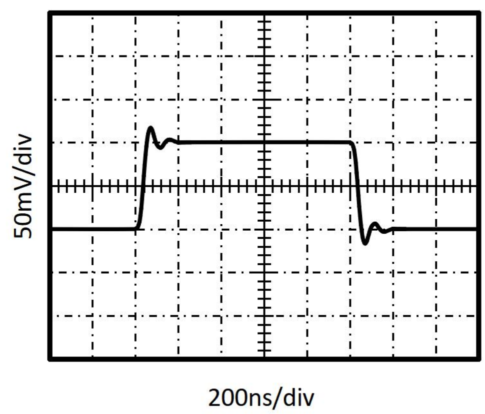


Figure 10. SMALL-SIGNAL STEP RESPONSE

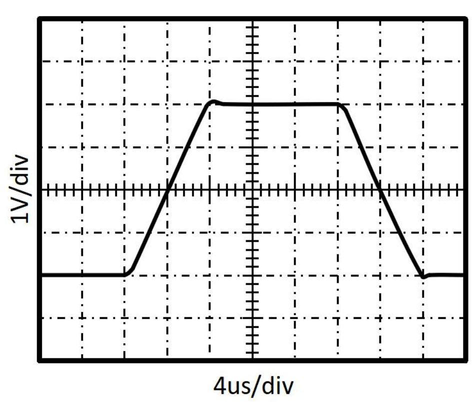


Figure 11. LARGE−SIGNAL STEP RESPONSE

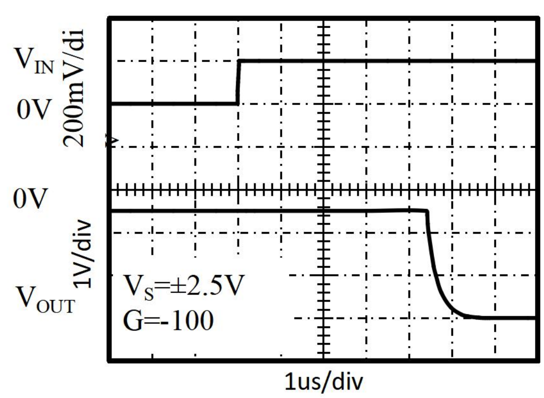


Figure 12. POSITIVE OVERVOLTAGE RECOVERY

TYPICAL CHARACTERISTICS

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

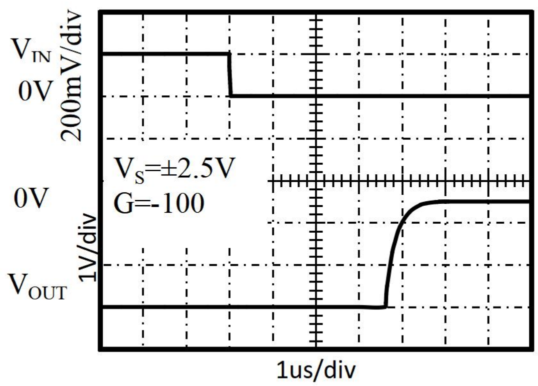


Figure 13. NEGATIVE OVERVOLTAGE RECOVERY

8 Detailed Description

8.1 Overview

The ZM633XP devices are unity-gain stable, dual and qual-channel op amps with low noise and distortion. The device consists of a low noise input stage with a folded cascade and a rail-to-rail output stage. This topology exhibits superior noise and distortion performance across a wide range of supply voltages that are not delivered by legacy commodity audio operational amplifiers.

8.2 Phase Reversal Protection

The ZM633XP family has internal phase-reversal protection. Many op amps exhibit phase reversal when the input is driven beyond the linear common-mode range. This condition is most often encountered in noninverting circuits when the input is driven beyond the specified common-mode voltage range, causing the output to reverse into the opposite rail. The input of the ZM633XP prevents phase reversal with excessive common-mode voltage. Instead, the appropriate rail limits the output voltage. This performance is shown in figure 14

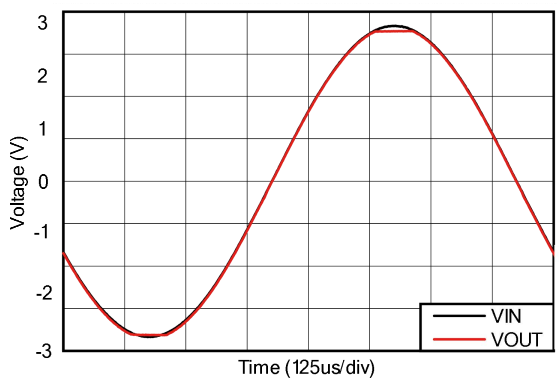


Figure 14. Output Waveform Devoid of Phase Reversal During an Input Overdrive Condition

8.3 EMI Rejection Ratio (EMIRR)

The electromagnetic interference (EMI) rejection ratio, or EMIRR, describes the EMI immunity of operational amplifiers. An adverse effect that is common to many operational amplifiers is a change in the offset voltage as a result of RF signal rectification. An operational amplifier that is more efficient at rejecting this change in offset as a result of EMI has a higher EMIRR and is quantified by a decibel value. Measuring EMIRR can be performed in many ways, but this document provides the EMIRR IN+, which specifically describes the EMIRR performance when the RF signal is applied to the noninverting input pin of the operational amplifier. In general, only the noninverting input is tested for EMIRR for the following three reasons:

• Operational amplifier input pins are known to be the most sensitive to EMI, and typically rectify RF signals better than the supply or output pins.

• The noninverting and inverting operational amplifier inputs have symmetrical physical layouts and exhibit nearly matching EMIRR performance.

• EMIRR is easier to measure on noninverting pins than on other pins because the noninverting input pin can be isolated on a printed-circuit-board (PCB). This isolation allows the RF signal to be applied directly to the noninverting input pin with no complex interactions from other components or connecting PCB traces.

Detailed Description (continued)

The EMIRR IN+ of the ZM633XP is plotted versus frequency in Figure 15. If available, any dual and quad operational amplifier device versions have approximately identical EMIRR IN+ performance. The ZM633XP unity-gain bandwidth is 1.1MHz. EMIRR performance below this frequency denotes interfering signals that fall within the operational amplifier bandwidth.

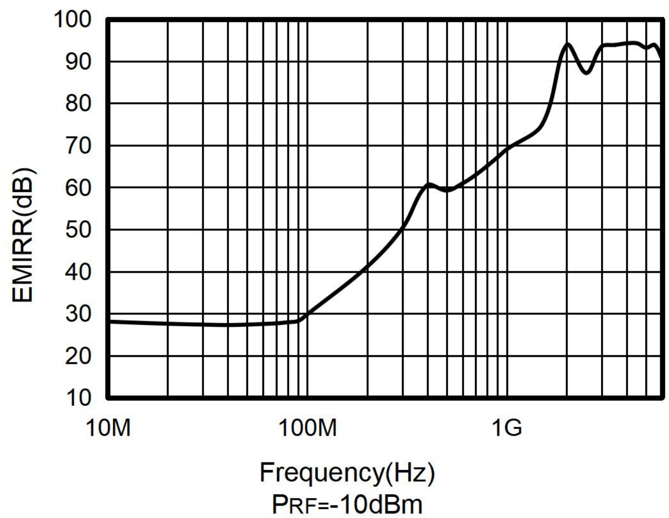


Figure 15. ZM633XP EMIRR vs Frequency

8.4 EMIRR IN+ Test Configuration

Figure 16 shows the circuit configuration for testing the EMIRR IN+. An RF source is connected to the operational amplifier noninverting input pin using a transmission line. The operational amplifier is configured in a unity-gain buffer topology with the output connected to a low-pass filter (LPF) and a digital multimeter (DMM). A large impedance mismatch at the operational amplifier input causes a voltage reflection; however, this effect is characterized and accounted for when determining the EMIRR IN+. The resulting dc offset voltage is sampled and measured by the multimeter. The LPF isolates the multimeter from residual RF signals that can interfere with multimeter accuracy.

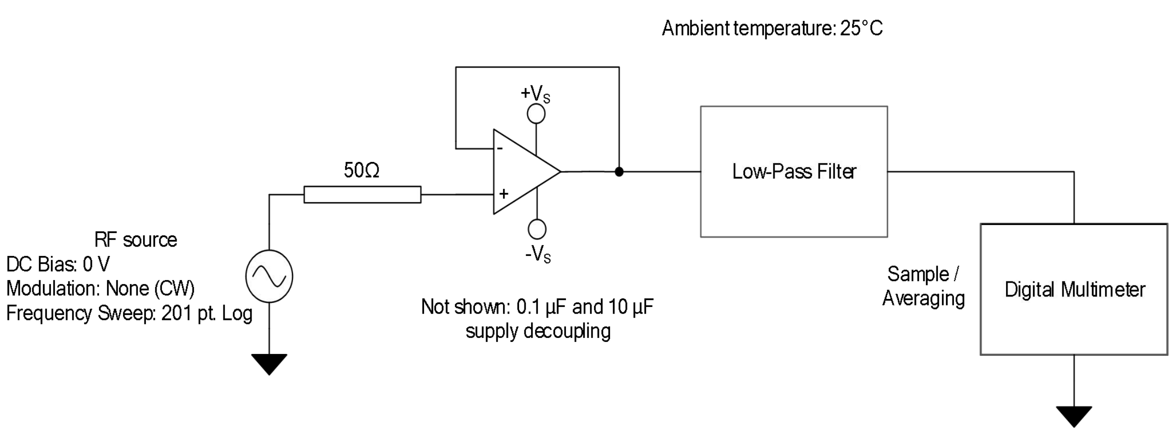


Figure 16. EMIRR IN+ Test Configuration Schematic

9 Application Notes

The ZM6331P, ZM6332P, ZM6334P are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.1V to 5.5V (±1.05V 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.

Typical Applications

9.1 25-kHz Low-pass Filter

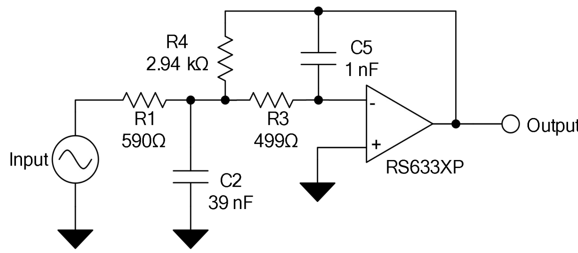


Figure 17. 25-kHz Low-Pass Filter

9.2 Design Requirements

Low-pass filters are commonly employed in signal processing applications to reduce noise and prevent aliasing. The ZM633XP devices are ideally suited to construct high-speed, high-precision active filters. Figure 17 shows a second-order, low-pass filter commonly encountered in signal processing applications.

Use the following parameters for this design example:

- Gain = 5 V/V (inverting gain)
- Low-pass cutoff frequency = 25 kHz
- Second-order Chebyshev filter response with 3-dB gain peaking in the passband

9.3 Detailed Design Procedure

The infinite-gain multiple-feedback circuit for a low-pass network function is shown in Figure 17. Use Equation 1 to calculate the voltage transfer function.

$$\frac{Output}{Input}(s) = \frac{-1/R_1R_3C_2C_5}{s^2 + (s/C_2)(1/R_1 + 1/R_3 + 1/R_4) + 1/R_3R_4C_2C_5} \quad (1)$$

This circuit produces a signal inversion. For this circuit, the gain at dc and the low-pass cutoff frequency are calculated by Equation 2:

$$Gain = \frac{R_4}{R_1}$$

$$f_C = \frac{1}{2\pi}\sqrt{(1/R_3R_4C_2C_5)} \quad (2)$$

9.4 Application Curve

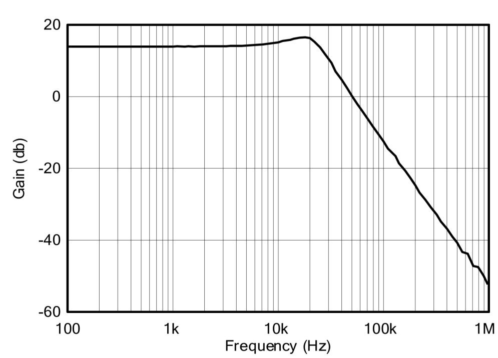


Figure 18. Low pass filter transfer function

10 Layout

10.1 Layout Guideline

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.

10.2 Layout Example

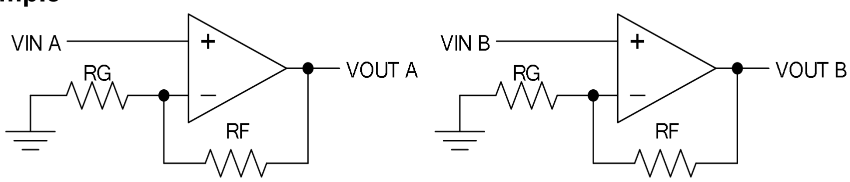


Figure 19. Schematic Representation

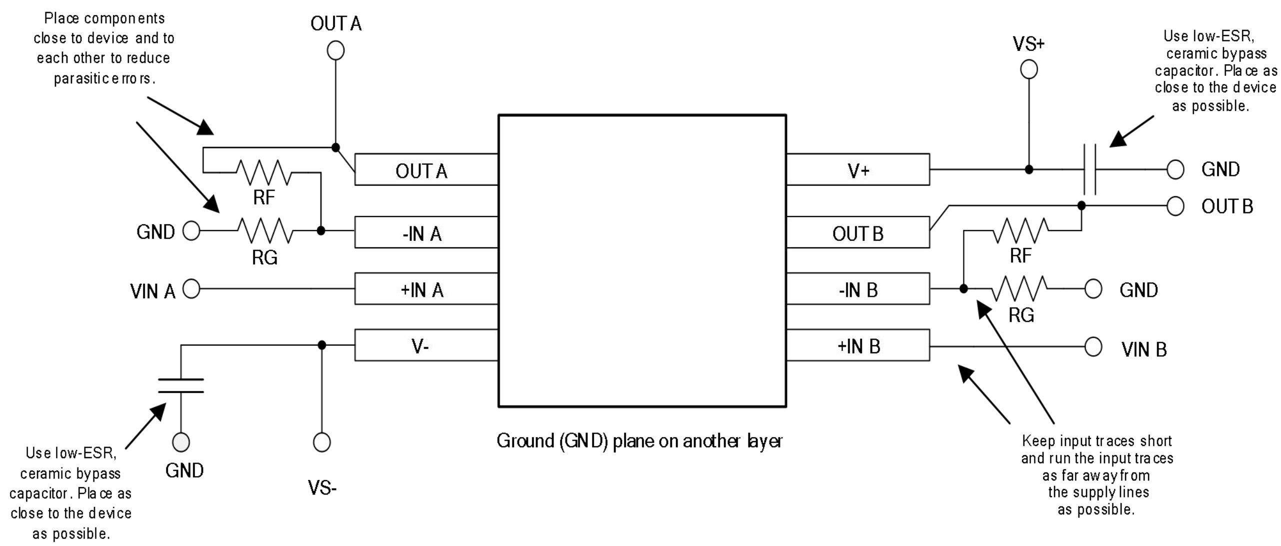
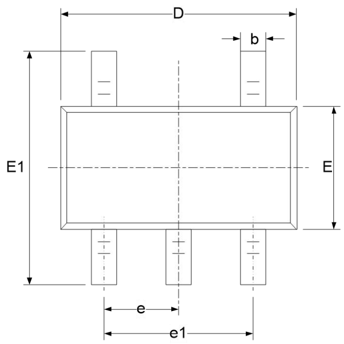
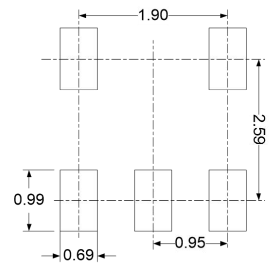


Figure 20. Layout Example

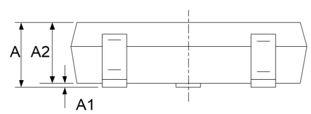
11 Pacakge Outline Dimensions

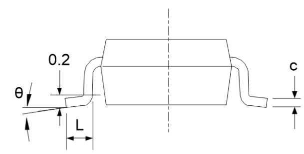
SOT23-5





RECOMMENDED LAND PATTERN (Unit: mm)



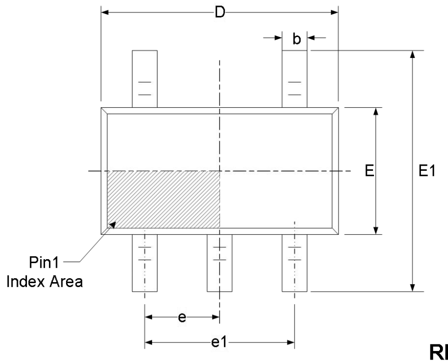


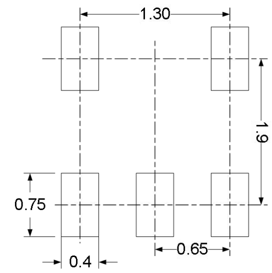
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)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

NOTE:

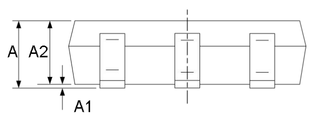
A. This drawing is subject to change without notice.
B. Plastic or metal protrusions of 0.15mm maximum per side are not included.
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

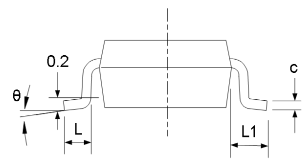
SOT353(SC70-5)





RECOMMENDED LAND PATTERN (Unit: mm)



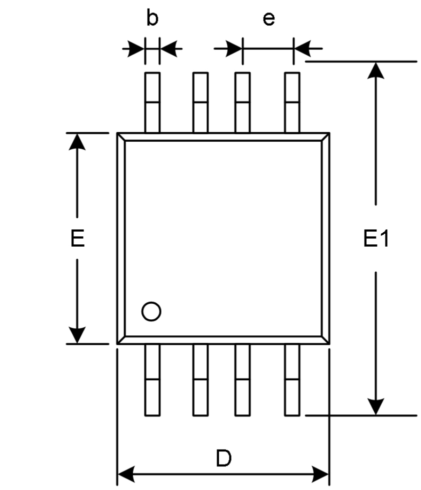


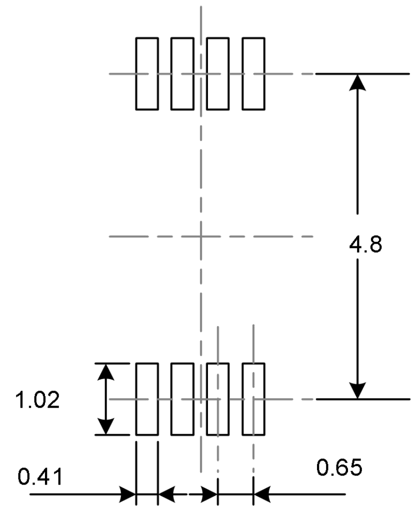
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650(BSC)		0.026(BSC)	
e1	1.300(BSC)		0.051(BSC)	
L	0.260	0.460	0.010	0.018
L1	0.525		0.021	
θ	0°	8°	0°	8°

NOTE:

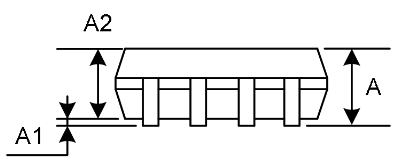
A. This drawing is subject to change without notice.
B. Plastic or metal protrusions of 0.15mm maximum per side are not included.
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

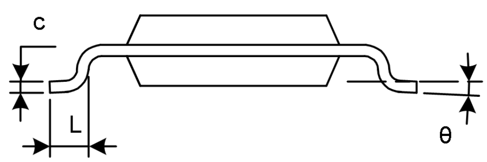
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)





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	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

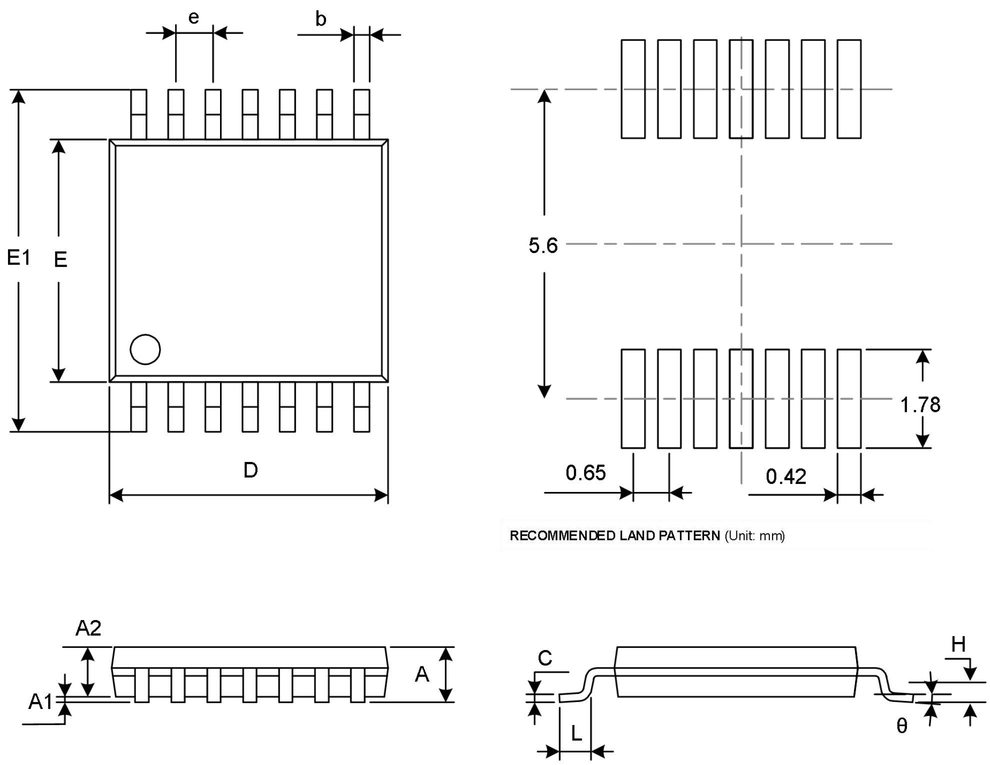
NOTE:

A. This drawing is subject to change without notice.

B. Plastic or metal protrusions of 0.15mm maximum per side are not included.

C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

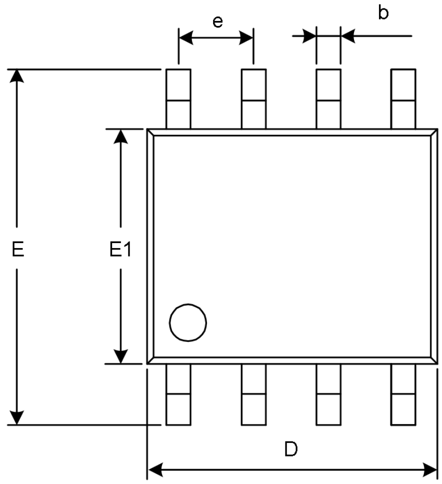
TSSOP-14

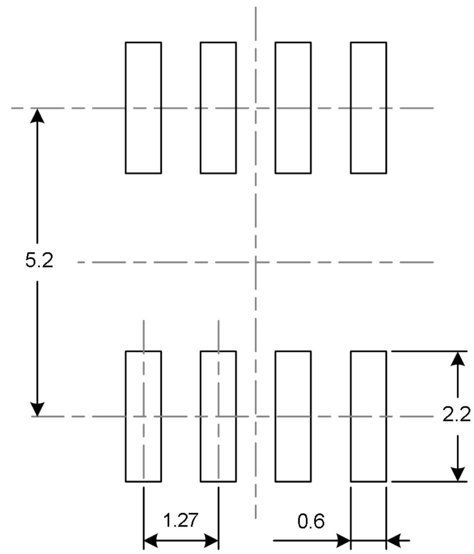


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

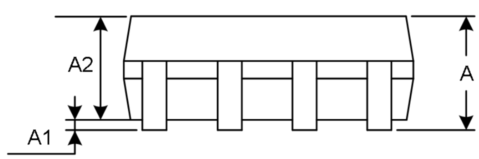
NOTE:
A. This drawing is subject to change without notice.
B. Plastic or metal protrusions of 0.15mm maximum per side are not included.
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

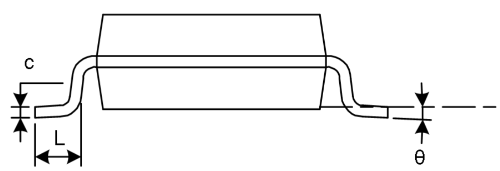
SOIC-8(SOP8)





RECOMMENDED LAND PATTERN (Unit: mm)



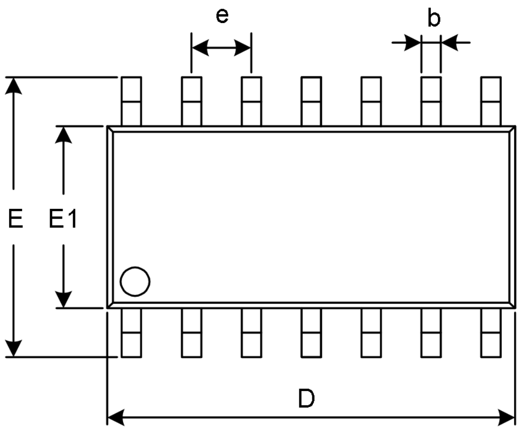


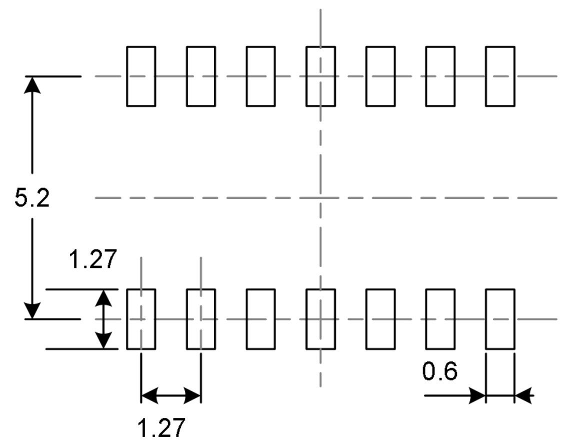
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

NOTE:

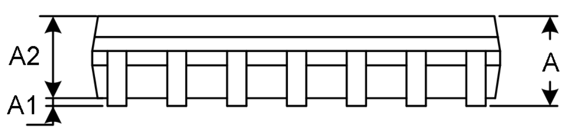
A. This drawing is subject to change without notice.
B. Plastic or metal protrusions of 0.15mm maximum per side are not included.
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

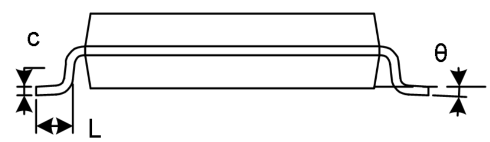
SOIC-14(SOP14)





RECOMMENDED LAND PATTERN (Unit: mm)



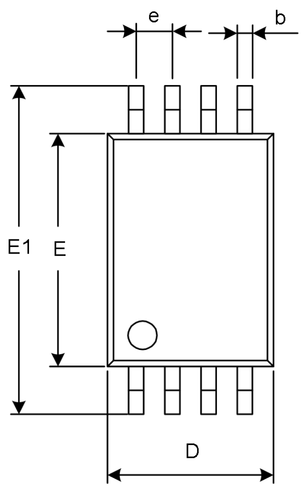


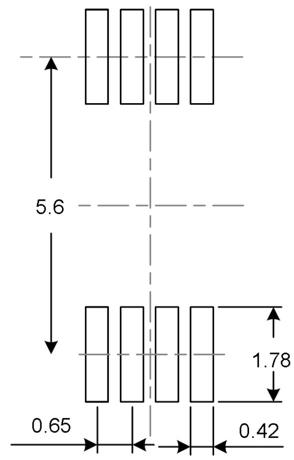
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

NOTE:

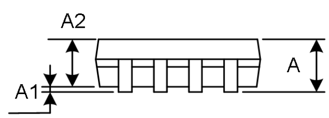
A. This drawing is subject to change without notice.
B. Plastic or metal protrusions of 0.15mm maximum per side are not included.
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

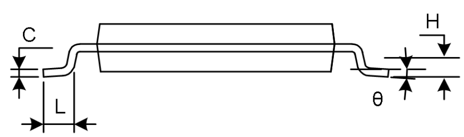
TSSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)





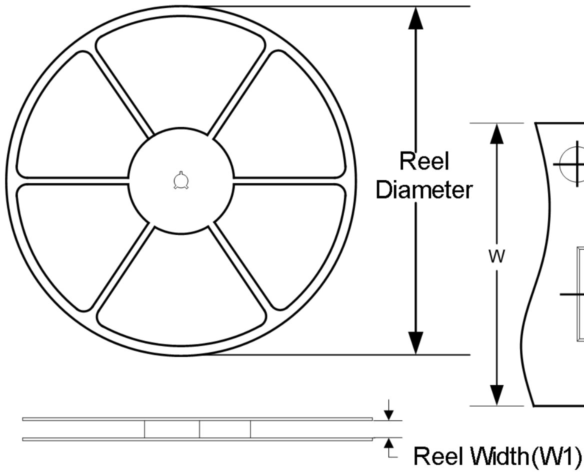
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

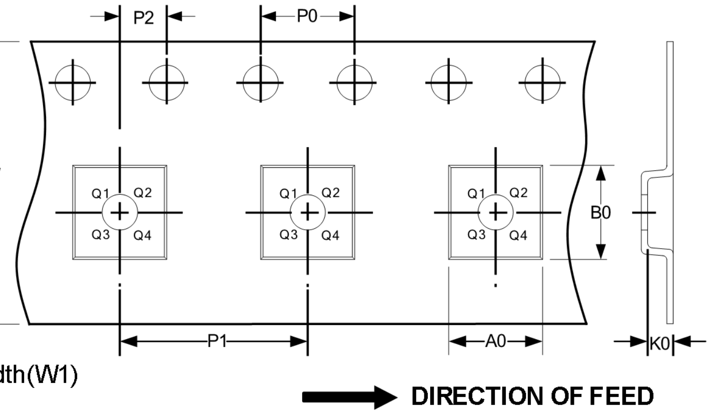
NOTE:

A. This drawing is subject to change without notice.
B. Plastic or metal protrusions of 0.15mm maximum per side are not included.
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

12 Tape and Reel Information

REEL DIMENSIONS **TAPE DIMENSION**





NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOIC-8(SOP8)	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP-8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOIC-14(SOP14)	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP-14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
SOT353(SC70-5)	7"	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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