

32V, 3.8MHz Rail-to-Rail Output CMOS Operational Amplifier

1 Features

- High Gain Bandwidth: 3.8MHz
- Input Offset Voltage: $\pm 0.8\text{mV}$ (Typical)
- Quiescent Current: 0.44mA/Amp
- Rail to Rail Output
- Supply Range: 3V to 32V
- Specified Up To +125°C
- Micro Size Packages: SOT23-5, SOP8, MSOP8, SOP14, TSSOP14

2 Applications

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

3 Descriptions

The ZM844X families of products offer high voltage (32V) operation and rail-to-rail output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (3.8MHz) and slew rate of 15V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

The input can operate normally within the negative power rail to 1.5V below of the positive power rail. Input signals beyond the supply rails do not cause phase reversal. The ZM844X families of operational amplifiers are specified at the full temperature range of -40°C to $+125^{\circ}\text{C}$ under single power supplies of 3V to 32V or dual power supplies of $\pm 1.5\text{V}$ to $\pm 16\text{V}$.

Device Information ⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE(NOM)
ZM8441	SOT23-5	2.90mm x 1.60mm
ZM8442	SOP8	4.90mm x 3.90mm
	MSOP8	3.00mm x 3.00mm
ZM8444	SOP14	8.65mm x 3.90mm
	TSSOP14	5.00mm x 4.40mm

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

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4 Revision History

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

VERSION	Change Date	Change Item
A.1	2023/10/18	Preliminary version completed

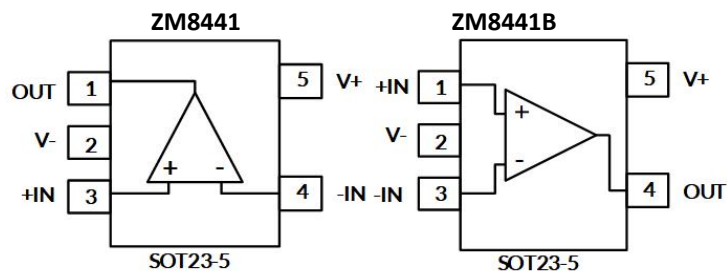
5 Package/Ordering Information ⁽¹⁾

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking ⁽²⁾	MSL ⁽³⁾	Package Qty
ZM8441XF	SOT23-5	5	1	-40°C ~125°C	8441	MSL3	Tape and Reel,3000
ZM8441BXF	SOT23-5	5	1	-40°C ~125°C	8441B	MSL3	Tape and Reel,3000
ZM8442XK	SOP8	8	2	-40°C ~125°C	ZM8442	MSL3	Tape and Reel,4000
ZM8442XM	MSOP8	8	2	-40°C ~125°C	ZM8442	MSL3	Tape and Reel,4000
ZM8444XP	SOP14	14	4	-40°C ~125°C	ZM8444	MSL3	Tape and Reel,4000
ZM8444XQ	TSSOP14	14	4	-40°C ~125°C	ZM8444	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)

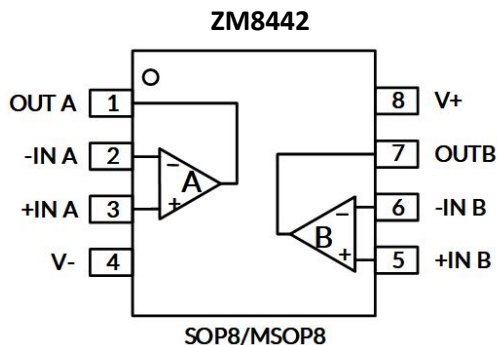


Pin Description

NAME	PIN		I/O ⁽¹⁾	DESCRIPTION
	ZM8441	ZM8441B		
+IN	3	1	I	Positive (noninverting) input
V-	2	2	-	Negative (lowest) power supply or ground (for single supply operation)
-IN	4	3	I	Negative (inverting) input
OUT	1	4	O	Output
V+	5	5	-	Positive (highest) power supply

(1) I = Input, O = Output.

Pin Configuration and Functions (Top View)

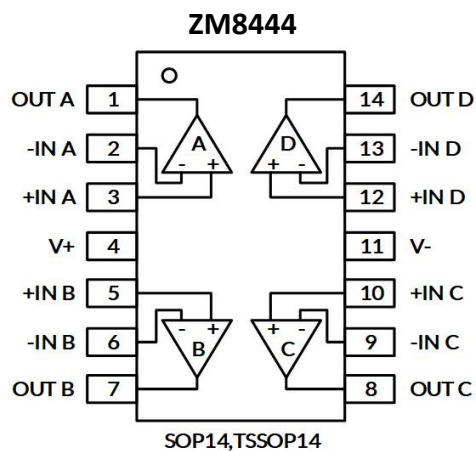


Pin Description

NAME	PIN	I/O ⁽¹⁾	DESCRIPTION
	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 or ground (for single supply operation)
V+	8	-	Positive (highest) power supply

(1) I = Input, O = Output.

Pin Configuration and Functions (Top View)



Pin Description

NAME	PIN	I/O ⁽¹⁾	DESCRIPTION
	SOP14/TSSOP14		
-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 or ground (for single supply operation)
V+	4	-	Positive (highest) power supply

(1) I = Input, O = Output.

7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Voltage	Supply, $V_s=(V+) - (V-)$	-0.7	36	V
	Signal input pin ⁽²⁾	(V-)-0.2	(V+) +0.2	
	Signal output pin ⁽³⁾	(V-)-0.2	(V+) +0.2	
Current	Signal input pin ⁽²⁾	-10	10	mA
	Signal output pin ⁽³⁾	-100	100	mA
	Output short-circuits ⁽⁴⁾	Continuous		
θ_{JA}	Package thermal impedance ⁽⁵⁾	SOT23-5	230	°C/W
		SOP8	110	
		MSOP8	170	
		SOP14	105	
		TSSOP14	90	
Temperature	Operating range, T_A	-40	125	°C
	Junction, T_J ⁽⁶⁾	-40	150	
	Storage, T_{stg}	-55	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 0.2V 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 0.2V beyond the supply rails should be current-limited to ± 100 mA or less.

(4) Short-circuit to ground, one amplifier per package.

(5) The package thermal impedance is calculated in accordance with JE5D-51.

(6) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A . The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

7.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM)	± 2000	V
		Charged-device model (CDM)	± 1500	



ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
Supply voltage, $V_s=(V+) - (V-)$	Single-supply	3		32	V
	Dual-supply	± 1.5		± 16	

7.4 Electrical Characteristics

(At $T_A = +25^\circ\text{C}$, $V_S = 3\text{V}$ to 32V , $R_L = 10\text{k}\Omega$ connected to $V_S/2$, and $V_{\text{OUT}} = V_S/2$, $V_{\text{CM}} = V_S/2$, Full ⁽⁹⁾ = -40°C to 125°C , unless otherwise noted.) ⁽¹⁾

PARAMETER	CONDITIONS	T_J	ZM844X			UNITS	
			MIN ⁽²⁾	TYP ⁽³⁾	MAX ⁽²⁾		
POWER SUPPLY							
V_S	Operating Voltage Range		25°C	3		32	V
I_Q	Quiescent Current Per Amplifier	$V_S = \pm 2.5\text{V}$, $I_O = 0\text{mA}$	25°C		0.44	0.7	mA
			Full			0.8	
		$V_S = \pm 16\text{V}$, $I_O = 0\text{mA}$	25°C		0.52	0.8	
			Full			0.9	
PSRR	Power-Supply Rejection Ratio	$V_S = 5\text{V}$ to 32V	25°C	95	120		dB
			Full	90			
INPUT							
V_{OS}	Input Offset Voltage	$V_{\text{CM}} = V_S/2$	25°C	-3.5	± 0.8	3.5	mV
			Full		± 1.1		
$V_{OS\ Tc}$	Input Offset Voltage Average Drift		Full		2		$\mu\text{V}/^\circ\text{C}$
IB	Input Bias Current ^{(4) (5)}	$V_{\text{CM}} = 0\text{V}$	25°C		± 10	± 25	pA
			Full		± 7000		
I_{OS}	Input Offset Current ⁽⁵⁾	$V_{\text{CM}} = 0\text{V}$	25°C		± 10		pA
			Full		± 7000		
V_{CM}	Common-Mode Voltage Range	$V_S = \pm 16\text{V}$	25°C	(V-)		(V+)-1.5	V
CMRR	Common-Mode Rejection Ratio	$V_S = \pm 16\text{V}$, $V_{\text{CM}} = -16\text{V}$ to 14.5V	25°C	85	120		dB
			Full	80			
OUTPUT							
A_{OL}	Open-Loop Voltage Gain	$R_L = 10\text{k}\Omega$, $V_O = (V-) + 0.6\text{V}$ to $(V+) - 0.6\text{V}$	25°C	100	120		dB
			Full	85			
V_{OH}	Output Swing	$V_S = \pm 16\text{V}$, $R_L = 10\text{k}\Omega$	25°C		15.65		V
V_{OL}						-15.65	V
I_{SC}	Short-circuit current ^{(6) (7)}	$V_S = \pm 5\text{V}$	25°C	15	43		mA
			Full	10			
FREQUENCY RESPONSE							
SR	Slew Rate ⁽⁸⁾	$G = +1$, $C_L = 100\text{pF}$	25°C	9	15		V/ μs
			Full	6			
GBW	Gain-Bandwidth Product		25°C	2.3	3.8		MHz
			Full	2.1			
t_s	Settling Time, 0.01%	$V_S = \pm 2.5\text{V}$, $G = +1$, $C_L = 100\text{pF}$, Step = 2V	25°C		1.5		μs
PM	Phase Margin	$V_S = 32\text{V}$, $R_L = 10\text{k}\Omega$, $C_L = 100\text{pF}$	25°C		60		$^\circ$
GM	Gain Margin	$V_S = 32\text{V}$, $R_L = 10\text{k}\Omega$, $C_L = 100\text{pF}$	25°C		15		
t_{OR}	Overload Recovery Time	$V_{\text{IN}} \cdot \text{Gain} \geq V_S$, $G = 11$	25°C		0.5		μs
t_{ON}	Turn On Time		25°C		8.5		μs
NOISE							
E_n	Input Voltage Noise	$f = 0.1\text{Hz}$ to 10Hz , $V_S = \pm 2.5\text{V}$	25°C		13.5		μVpp

en	Input Voltage Noise Density	f = 1KHz	25°C		30		nV/ $\sqrt{\text{Hz}}$
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NOTE:

- (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) Positive current corresponds to current flowing into the device.
- (5) This parameter is ensured by design and/or characterization and is not tested in production.
- (6) The maximum power dissipation is a function of $T_{J(\text{MAX})}$, $R_{\theta JA}$, and T_A . The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(\text{MAX})} - T_A) / R_{\theta JA}$. 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 $T_A = +25^\circ\text{C}$, $V_S = \pm 16\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{OUT} = V_S/2$, unless otherwise noted.

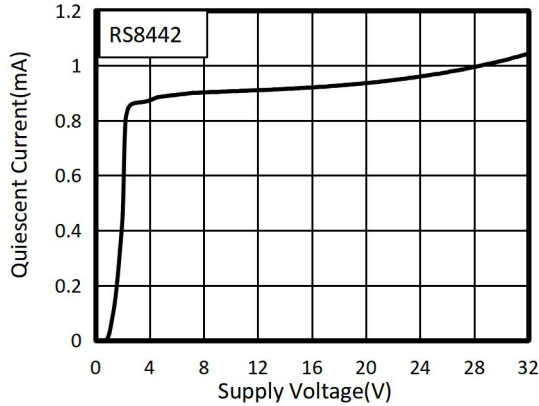


Figure 1. Supply Voltage vs Quiescent Current

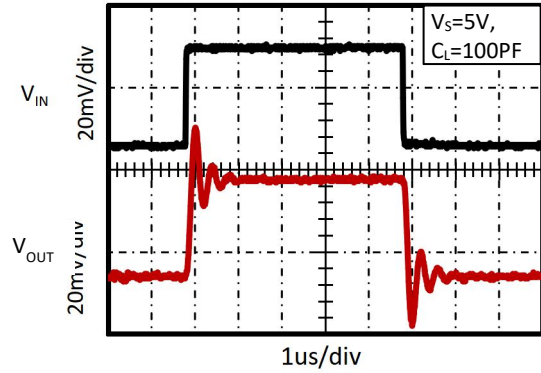


Figure 2. SMALL-SIGNAL STEP RESPONSE

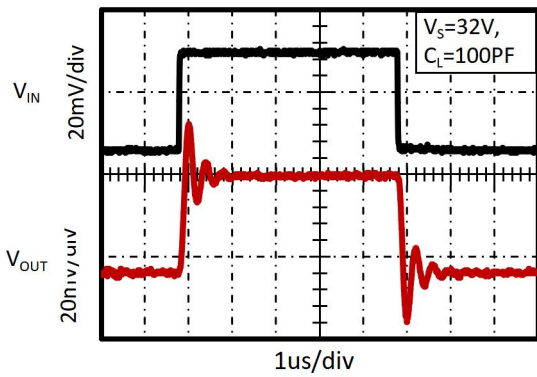


Figure 3. SMALL-SIGNAL STEP RESPONSE

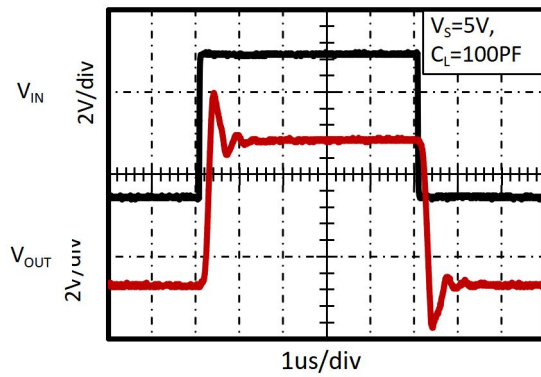


Figure 4. LARGE-SIGNAL STEP RESPONSE

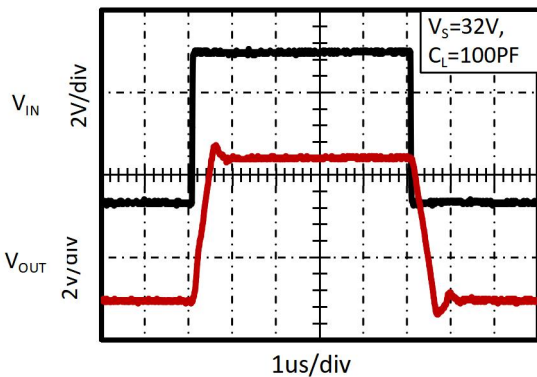


Figure 5. LARGE-SIGNAL STEP RESPONSE

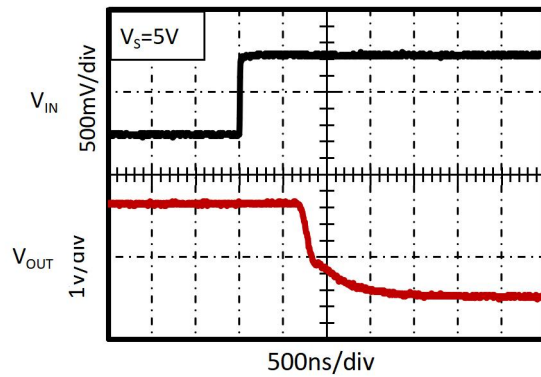


Figure 6. Positive Overload Recovery

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 $T_A = +25^\circ\text{C}$, $V_S = \pm 16\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{OUT} = V_S/2$, unless otherwise noted.

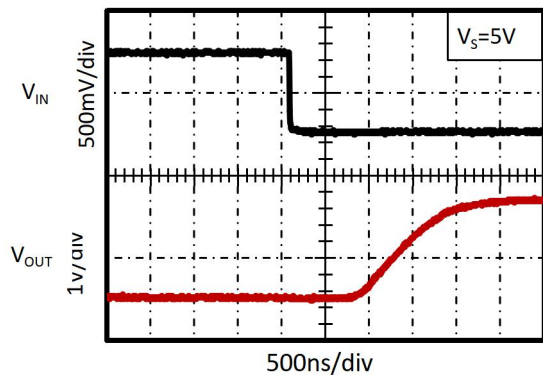


Figure 7. Negative Overload Recovery

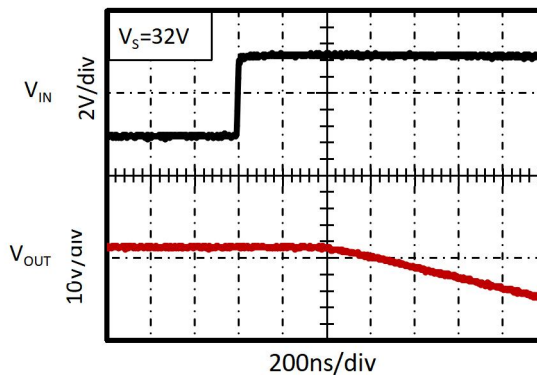


Figure 8. Positive Overload Recovery

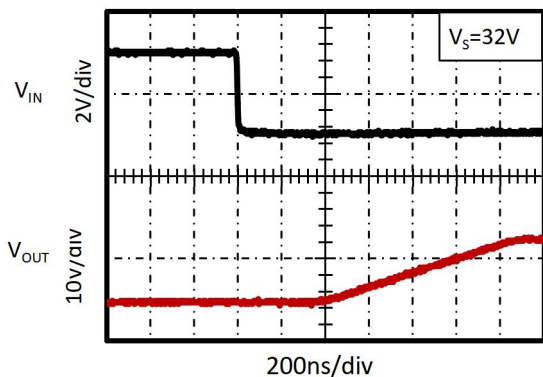
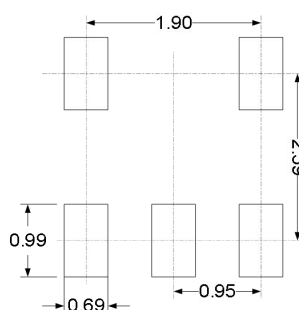
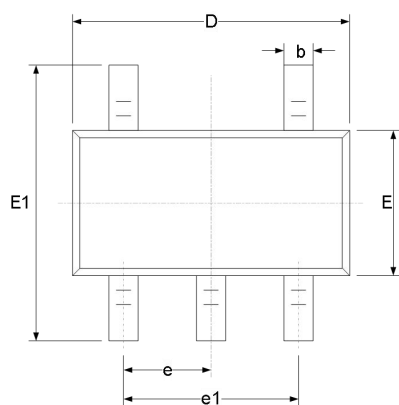
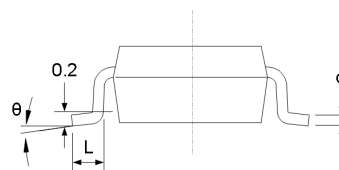
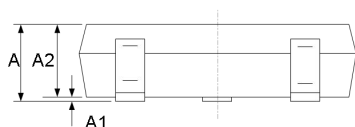


Figure 9. Negative Overload Recovery

8 Package Outline Dimensions
SOT23-5⁽³⁾



RECOMMENDED LAND PATTERN (Unit: mm)

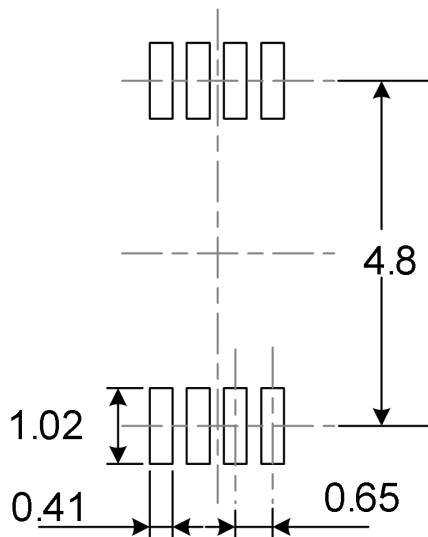
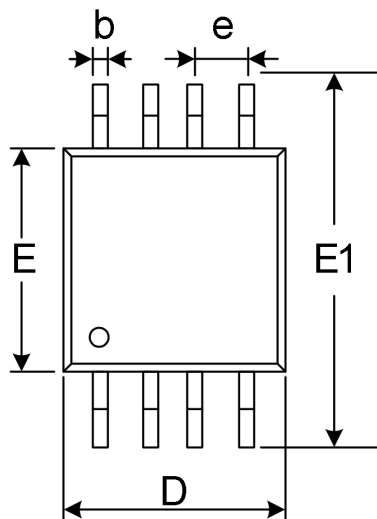


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A ⁽¹⁾	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D ⁽¹⁾	2.820	3.020	0.111	0.119
E ⁽¹⁾	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC) ⁽²⁾		0.037(BSC) ⁽²⁾	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

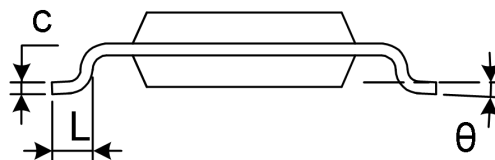
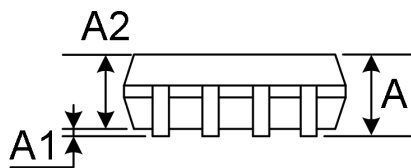
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

MSOP8⁽³⁾



RECOMMENDED LAND PATTERN (Unit: mm)

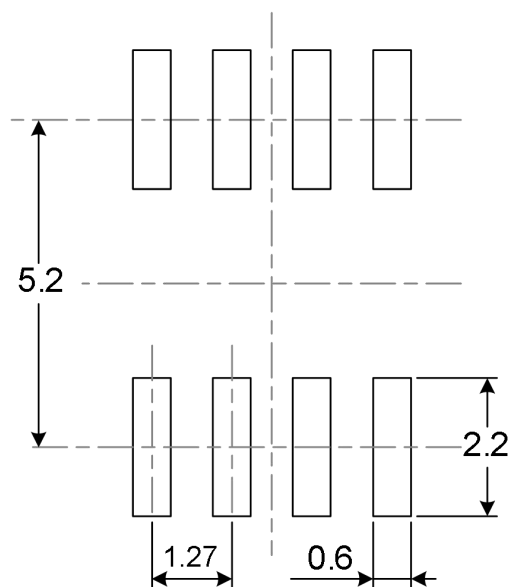
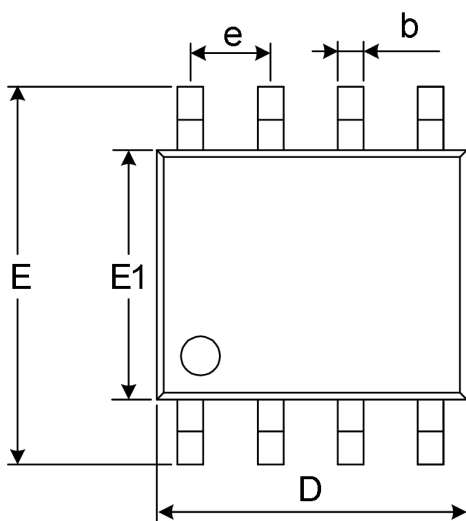


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A ⁽¹⁾	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
<i>b</i>	0.250	0.380	0.010	0.015
<i>c</i>	0.090	0.230	0.004	0.009
D ⁽¹⁾	2.900	3.100	0.114	0.122
<i>e</i>	0.650(BSC) ⁽²⁾		0.026(BSC) ⁽²⁾	
E ⁽¹⁾	2.900	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°

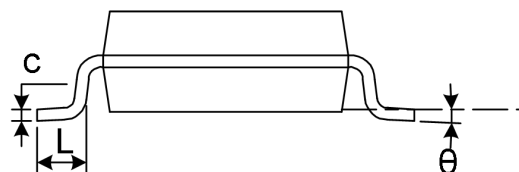
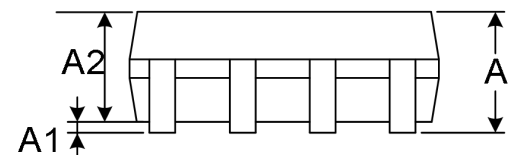
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

SOP8⁽³⁾



RECOMMENDED LAND PATTERN (Unit: mm)

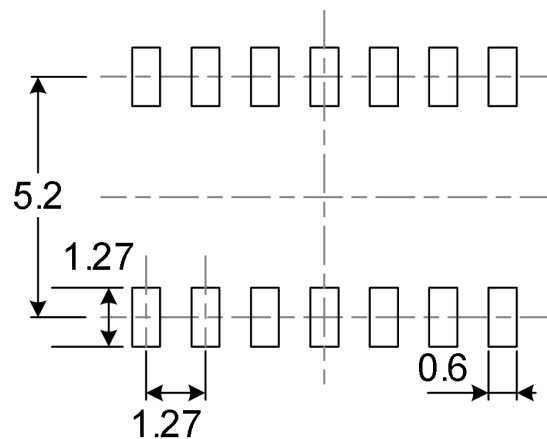
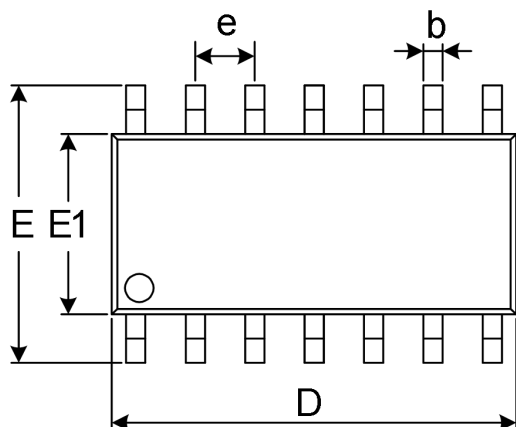


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A ⁽¹⁾	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D ⁽¹⁾	4.800	5.000	0.189	0.197
e	1.270(BSC) ⁽²⁾		0.050(BSC) ⁽²⁾	
E	5.800	6.200	0.228	0.244
E1 ⁽¹⁾	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

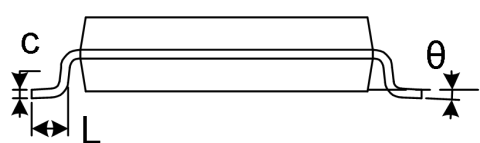
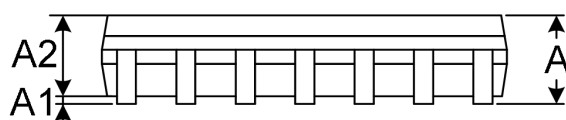
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

SOP14⁽³⁾



RECOMMENDED LAND PATTERN (Unit: mm)

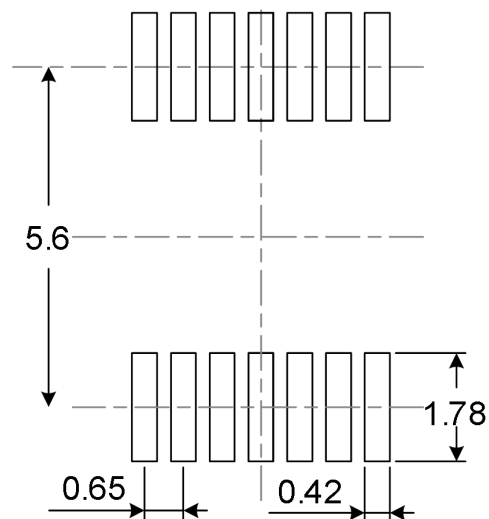
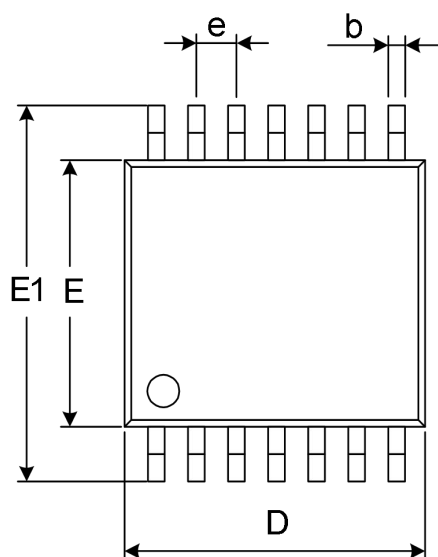


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A ⁽¹⁾	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D ⁽¹⁾	8.450	8.850	0.333	0.348
e	1.270(BSC) ⁽²⁾		0.050(BSC) ⁽²⁾	
E	5.800	6.200	0.228	0.244
E1 ⁽¹⁾	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

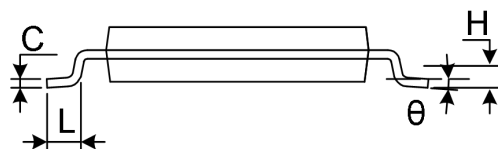
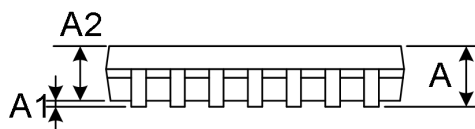
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

TSSOP14⁽³⁾



RECOMMENDED LAND PATTERN (Unit: mm)

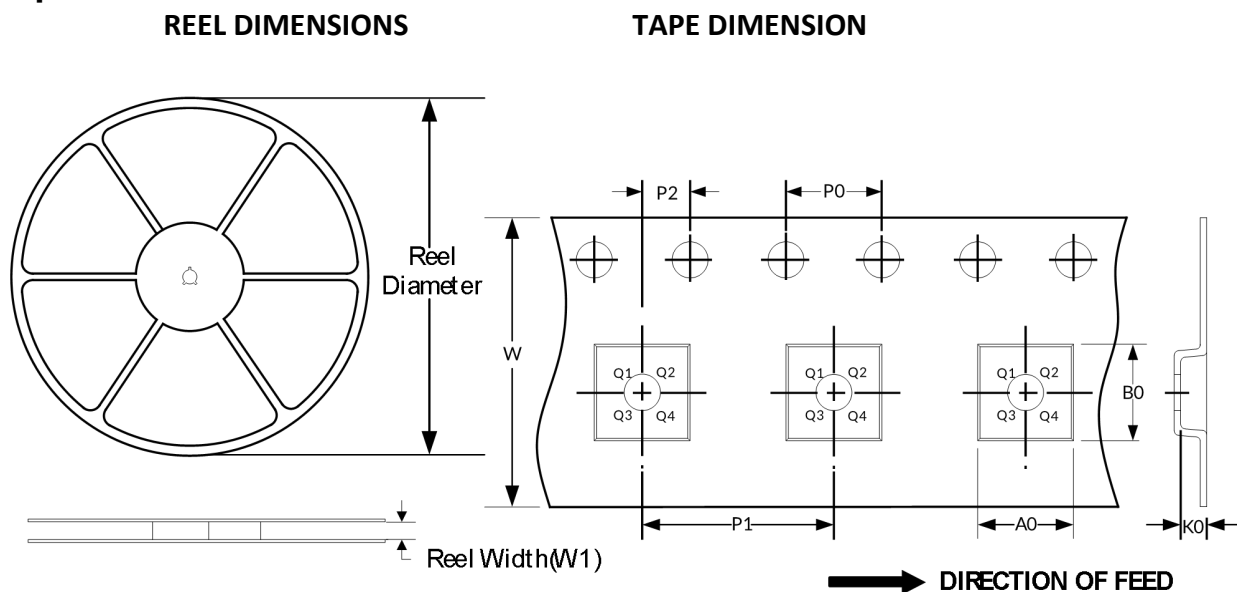


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A ⁽¹⁾		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D ⁽¹⁾	4.860	5.100	0.191	0.201
E ⁽¹⁾	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC) ⁽²⁾		0.026(BSC) ⁽²⁾	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

9 Tape and Reel Information



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 W1(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
SOP8	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOP14	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	14.0	Q1

NOTE:

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

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