Precision, Zero-Drift, Rail-to-Rail Out, High-Voltage(32V) Operational Amplifier

1 Features

- **Gain-Bandwidth Product:2.0MHz**
- **Low Offset Voltage:50μV (Max)**
- **Input Offset Drift: ±0.15μV/°C**
- **Low Input Niose:0.6μVpp (0.1Hz to 10Hz)**
- **Low Supply Current:1.8mA (TYP)**
- **Rail to Rail Output**
- **Excellent DC Precision:**
  -PSRR:130dB
  -CMRR:120dB
  -Open-Loop Gain:130dB
- **Single-Supply Operation: 3.3V to 32V**
- **Dual-Supply Operation: ±1.65V to ±16V**
- **Specified up to +125°C**
- **Packages: SOIC-8/MSOP-8**

2 Applications

- **Temperature Measurements**
- **Semiconductor Test**
- **Pressure Sensors**
- **Medical Equipment**
- **Test Equipment**
- **Driving A/D Converters**
- **Precision Current Sensing**

3 Descriptions

The ZM8652 CMOS operational amplifier use auto-zero techniques to simultaneously provide very low offset voltage (50μV max) and near-zero drift over time and temperature. This family of amplifiers has ultra-low noise, offset and power.

This miniature, high-precision operational amplifiers offset high input impedance and rail-to-rail output swing. With high gain-bandwidth product of 2.0MHz and slew rate of 1.0V/μs. Either single or dual supplies can be used in the range from 3.3V to 32V (±1.65V to ±16V).

The ZM8652 operational amplifier is specified at the full temperature range of −40°C to +125°C.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
ZM8652	SOIC-8(SOP8)	4.90mm x 3.90mm
	MSOP-8	3.00mm x 3.00mm

(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 different from page numbers in the current version.

VERSION	Change Date	Change Item
A.1	2022/09/14	Initial version completed

5 Package/Ordering Information (1)

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking (2)	MSL (3)	Package Qty
ZM8652XK	SOIC-8(SOP8)	8	2	-40°C ~125°C	ZM8652	MSL3	Tape and Reel,4000
ZM8652XM	MSOP-8	8	2	-40°C ~125°C	ZM8652	MSL3	Tape and Reel,4000

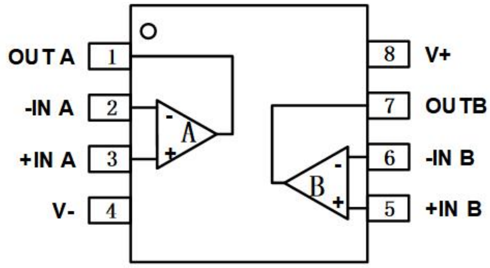
NOTE:

(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) The MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F.

6 Pin Configuration and Functions (Top View)



Pin Description

NAME	PIN	I/O [(1)]	DESCRIPTION
	SOIC-8(SOP8)/MSOP-8		
-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.

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-)	Dual supply		±18	V
		Single supply		36	
	Signal input pin (2)	Common-mode voltage	(V-)-0.5	(V+) +0.5	
		Differential voltage		±0.7	
	Signal output pin (3)		(V-)-0.5	(V+) +0.5	
Current	Signal input pin (2)		-10	10	mA
	Signal output pin (3)		-50	50	mA
	Output short-circuits (4)		Continuous		
θ_{JA}	Package thermal impedance (5)	SOIC-8(SOP8)		110	°C/W
		MSOP-8		170	
Temperature	Operating range, T_A		-40	125	°C
	Junction, T_J (6)		-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 ±50mA or less.
(4) Short-circuit to ground, one amplifier per package.
(5) The package thermal impedance is calculated in accordance with JESD-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), per ANSI/ESDA/JEDEC JS-001(1)	±2500	V
		Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002(2)	±1500	
		Machine Model (MM)	±500	

(1) JEDEC document JEP155 states that 500 V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250 V CDM allows safe manufacturing with a standard ESD control process.

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	3.3		32	V
	Dual-supply	±1.65		±16	

7.4 Electrical Characteristics

At T_A = +25°C, V_S=3.3V to 32V, R_L = 10kΩ connected to V_S/2, and V_{CM}=V_{OUT} = V_S/2, Full [9] = -40°C to +125°C (unless otherwise noted) [1]

PARAMETER		CONDITIONS	T_J	ZM8652			UNIT
				MIN[2]	TYP[3]	MAX[2]	
POWER SUPPLY							
V_S	Operating Voltage Range		25°C	3.3		32	V
IQ	Quiescent Current	V_S=±2.5V, Io=0mA	25°C		1.8	2.5	mA
			Full			3.0	
		Vs=±16V, Io=0mA	25°C		2.2	4.0	
			Full			5.0	
PSRR	Power-Supply Rejection Ratio	V_S=5V to 32V	25°C	110	130		dB
			Full	100			
INPUT							
Vos	Input Offset Voltage	V_{CM}= V_S/2	25°C	-50	±3	50	μV
			Full		±25		
Vos Tc	Input Offset Voltage Average Drift	V_{CM}= V_S/2	Full		±0.15		μV/°C
IB	Input Bias Current [4] [5]	V_{CM}=0V	25°C		100	1000	pA
			Full		600		
I_{OS}	Input Offset Current [4]	V_{CM}=0V	25°C		100		pA
			Full		600		
V_{CM}	Common-Mode Voltage Range	V_S= ±16V	25°C	(V-)		(V+)-1.5	V
CMRR	Common-Mode Rejection Ratio	V_S= ±16V V_{CM}=(V-)+0.3 to (V+)-1.5V	25°C	95	120		dB
			Full	90			
OUTPUT							
A_{OL}	Open-Loop Voltage Gain	R_L=10KΩ Vo=(V-)+0.4V to (V+)-0.4V	25°C	100	130		dB
			Full	90			
V_{OH}	Output Swing from Rail	V_S=±16V, R_L=10KΩ	25°C	15.80			V
V_{OL}			25°C			-15.70	
I_{SC}	Short-Circuit Current [6] [7]	V_S=±2.5V, Vo=0V	25°C	15	20		mA
		V_S=±16V, Vo=0V		60	80		
Ro	Open-loop Output Impedance [4]	f=1MH, Io=0mA			120		Ω
C_{LOAD}	Capacitive Load Drive [4]				1		nF
FREQUENCY RESPONSE							
SR	Slew Rate [8]	V_S=±2.5V, G=+1, C_L=100pF	25°C		1.0		V/μs
GBW	Gain-Bandwidth Product	V_S=±2.5V	25°C		2.0		MHz
ts	Settling Time,0.1%	V_S=±2.5V, G=+1, C_L=100pF, Step=2V	25°C		6.6		μs
t_{OR}	Overload Recovery Time	V_{IN}·Gain≥V_S, G=-10	25°C		1.6		μs
NOISE							
En	Input Voltage Noise	f = 0.1Hz to 10Hz, V_S=±2.5V	25°C		0.6		μVpp
en	Input Voltage Noise Density [4]	f = 1KHz	25°C		30		$nV/\sqrt{Hz}$
		f = 10KHz			14		

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) 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 $T_{J(MAX)}$, $R_{θJA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is PD = ($T_{J(MAX)}$ - T_A) / $R_{θJA}$. 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 =-40°C to 125°C, V_S=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

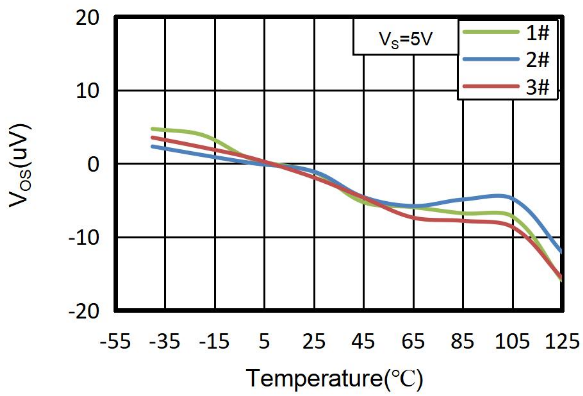


Figure 1. Offset Voltage vs Temperature

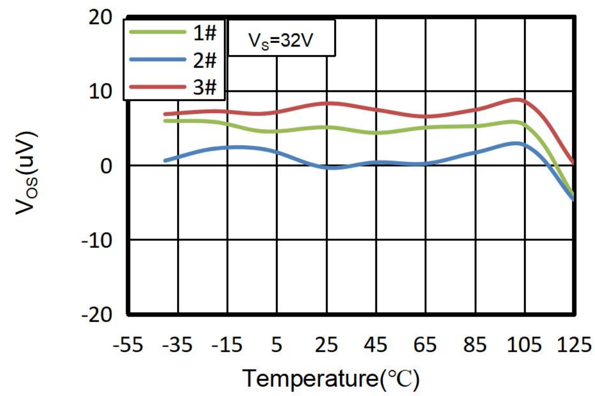


Figure 2. Offset Voltage vs Temperature

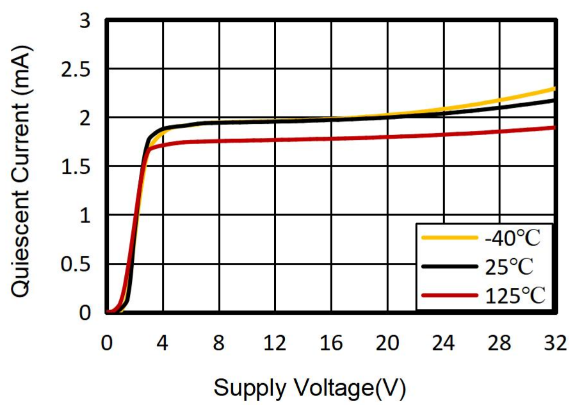


Figure 3. Supply Voltage vs Quiescent Current

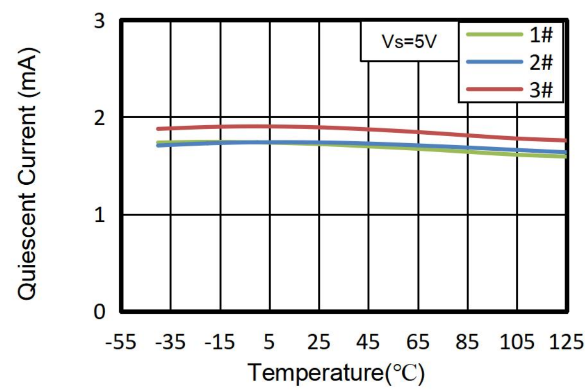


Figure 4. Quiescent Current vs Temperature

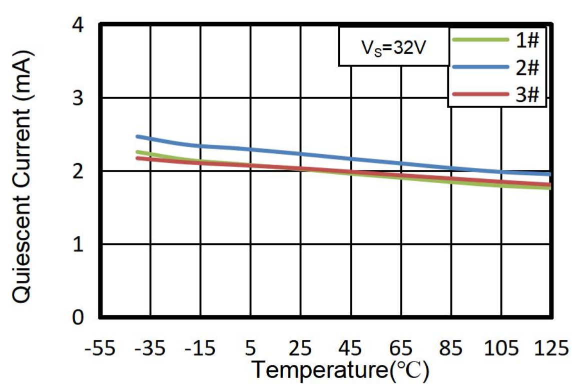


Figure 5. Quiescent Current vs Temperature

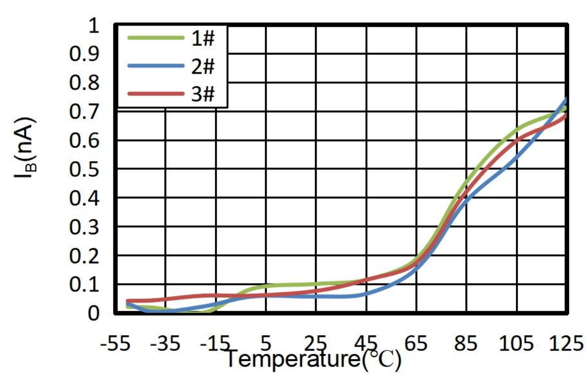


Figure 6. Input Bias Current vs Temperature

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 =-40°C to 125°C, V_S=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

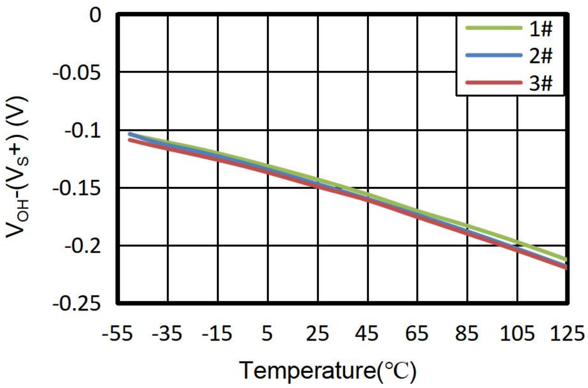


Figure 7. Output Swing From Rail vs Temperature

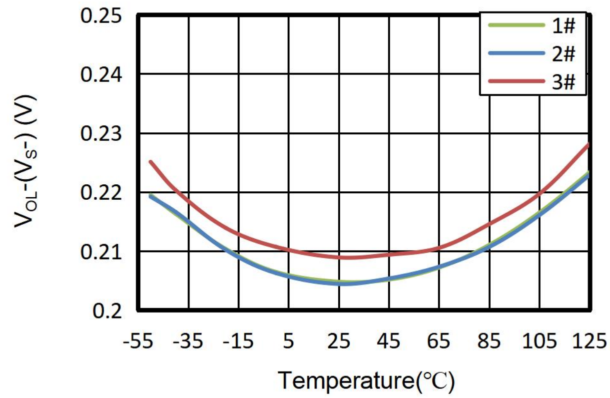


Figure 8. Output Swing From Rail vs Temperature

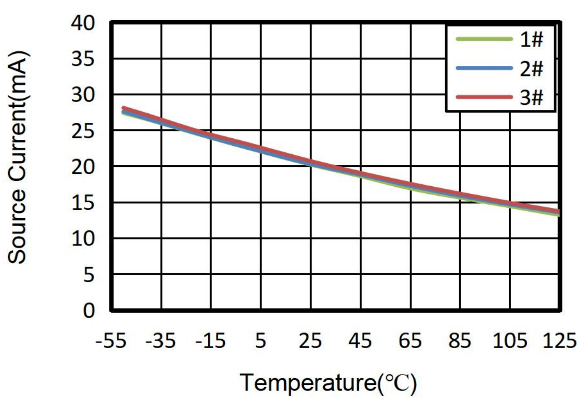


Figure 9. Source Current vs Temperature

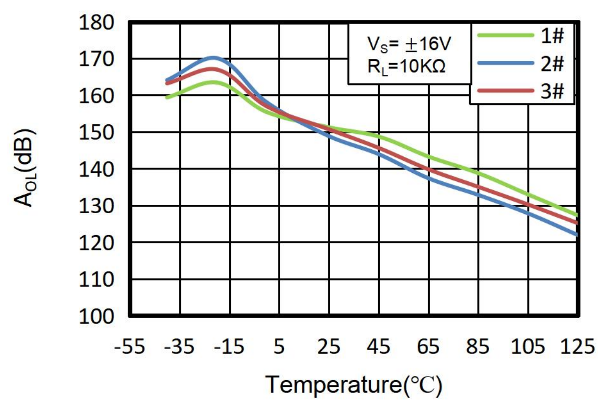


Figure 10. Open-Loop Gain vs Temperature

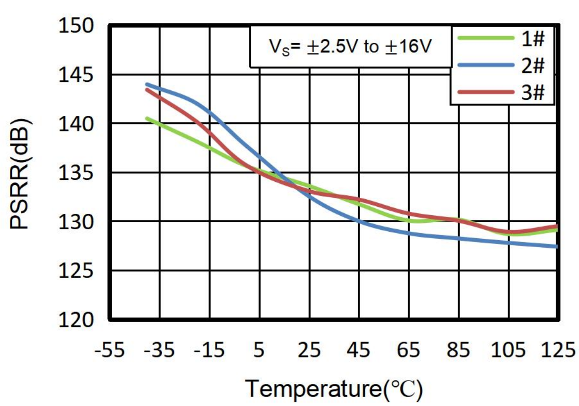


Figure 11. Power-Supply Rejection Ratio vs Temperature

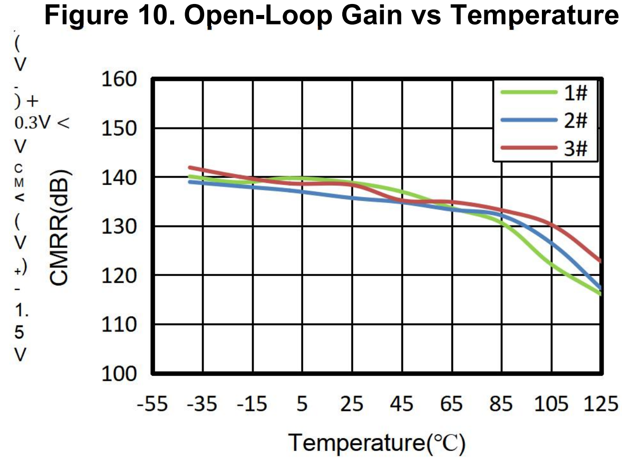


Figure 12. Common-Mode Rejection Ratio vs Temperature

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 =-40°C to 85°C, V_S=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

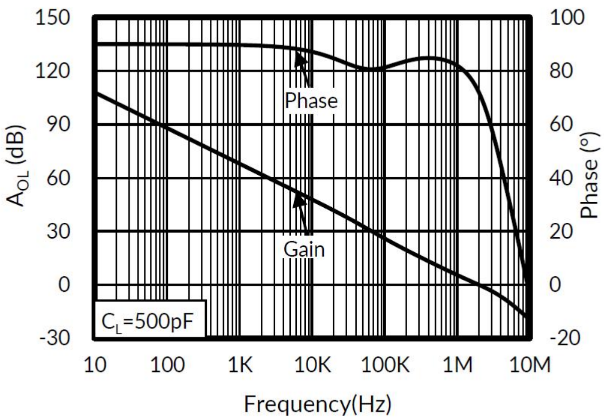
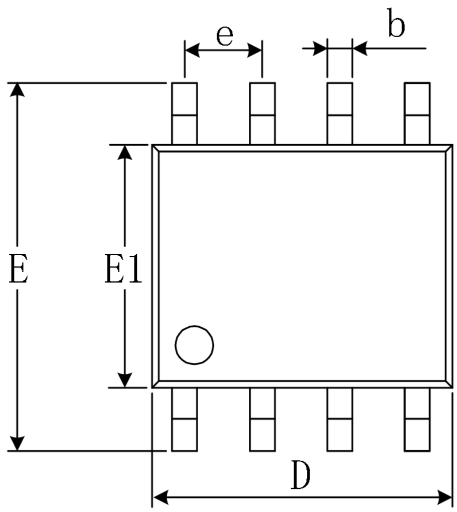
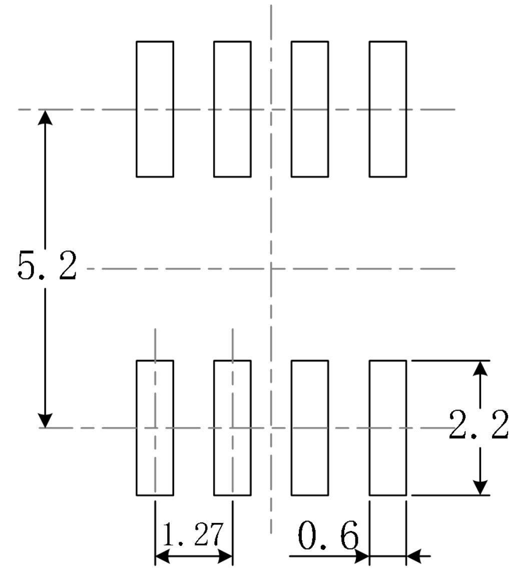


Figure 13. Open-Loop Gain and Phase vs Frequency

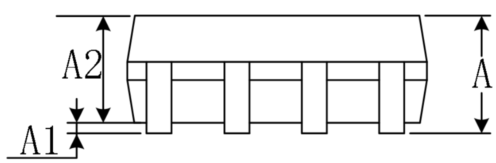
8 Package Outline Dimensions

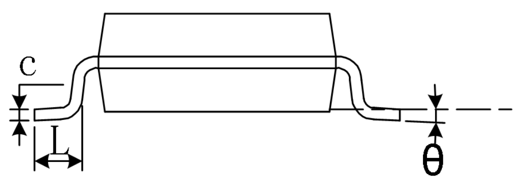
SOIC-8(SOP8)





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°

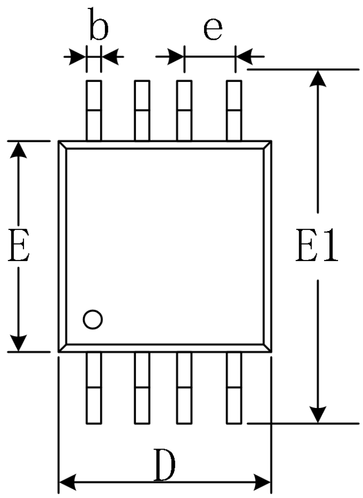
NOTE:

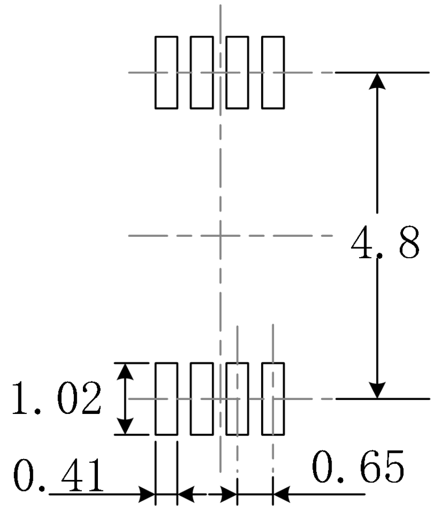
A. This drawing is subject to change without notice.

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

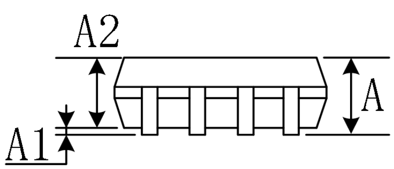
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

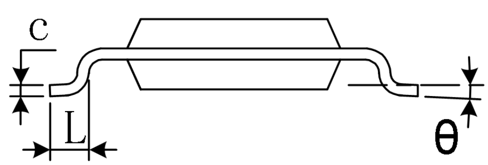
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)



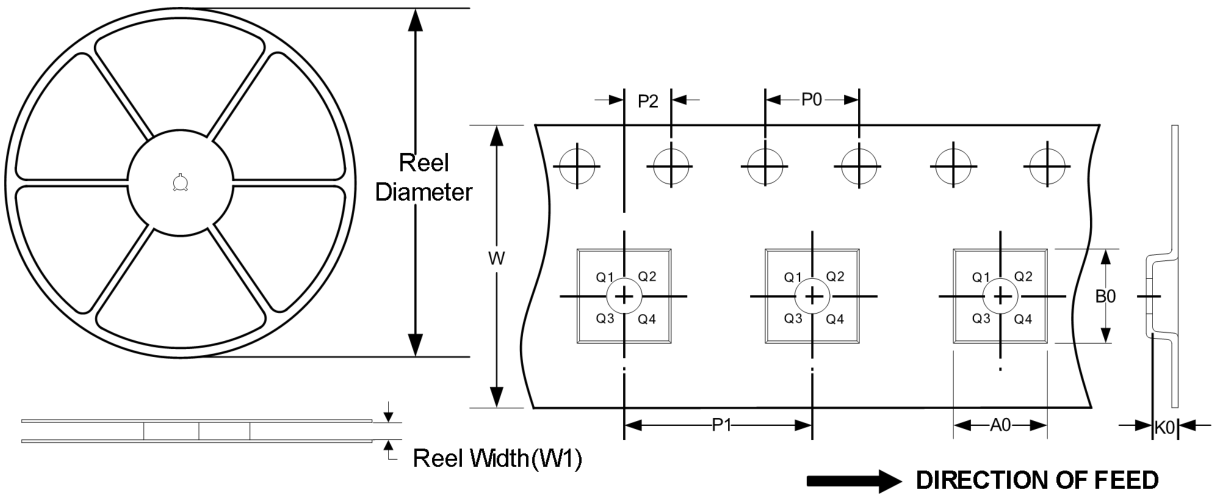


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	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.

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 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
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

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

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