

5kHz, 400nA, Rail-to-Rail I/O CMOS Operational Amplifier

1 FEATURES

- **Gain Bandwidth: 5kHz**
- **Rail-to-Rail Input and Output**
0.5mV Typical Vos
- **Input Voltage Range: -0.1V to +5.6V**
with Vs = 5.5V
- **Supply Range: +1.4V to +5.5V**
- **Specified Up to +125°C**
- **Micro Size Packages: SOT23-5**

2 APPLICATIONS

- **Sensors**
- **Photodiode Amplification**
- **Wearable Products**
- **Temperature Measurement**
- **Battery Powered System**

3 DESCRIPTIONS

The RS8021, RS8022, RS8024, 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 (5kHz) and slew rate of 1.5V/ms. The op-amps are unity gain stable and feature an ultra-low input bias current.

The devices are ideal for sensor interfaces, active filters and portable applications. The RS8021, RS8022, RS8024 families of operational amplifiers are specified at the full temperature range of -40°C to +125°C under single or dual power supplies of 1.4V to 5.5V.

Device Information ⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS8021	SOT23-5	2.90mm×1.60mm
	SOP8	4.90mm×3.90mm
	MSOP8	3.00mm×3.00mm
RS8022	SOP8	4.90mm×3.90mm
	MSOP8	3.00mm×3.00mm
	DFN3X3-8	3.00mm×3.00mm
RS8024	SOP14	8.65mm×3.90mm
	TSSOP14	5.00mm×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
C.1	2024/03/04	1. Update Package Qty on Page 2@RevB.1 2. Added TAPE AND REEL INFORMATION 3. Modify packaging naming
C.2	2024/06/27	1. Add MSL on Page 7@RevC.1 2. Update PIN CONFIGURATION AND FUNCTIONS 3. Add Package thermal impedance on Page 5@RevC.1 4. Update PACKAGE note

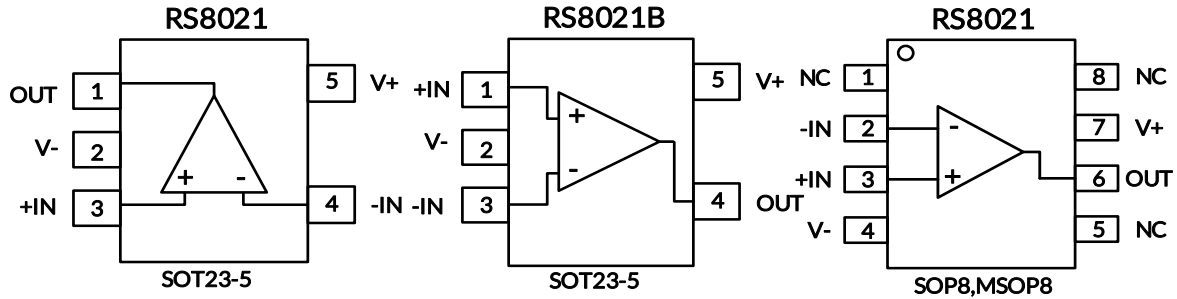
5 PACKAGE/ORDERING INFORMATION ⁽¹⁾

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking ⁽²⁾	MSL ⁽³⁾	Package Qty
RS8021XF	SOT23-5	5	1	-40°C ~125°C	8021	MSL3	Tape and Reel, 3000
RS8021BXF	SOT23-5	5	1	-40°C ~125°C	8021B	MSL3	Tape and Reel, 3000
RS8021XK	SOP8	8	1	-40°C ~125°C	RS8021	MSL3	Tape and Reel, 4000
RS8021XM	MSOP8	8	1	-40°C ~125°C	RS8021	MSL3	Tape and Reel, 4000
RS8022XK	SOP8	8	2	-40°C ~125°C	RS8022	MSL3	Tape and Reel, 4000
RS8022XM	MSOP8	8	2	-40°C ~125°C	RS8022	MSL3	Tape and Reel, 4000
RS8022XT	DFN3X3-8	8	2	-40°C ~125°C	RS8022	MSL3	Tape and Reel, 5000
RS8024XP	SOP14	14	4	-40°C ~125°C	RS8024	MSL3	Tape and Reel, 4000
RS8024XQ	TSSOP14	14	4	-40°C ~125°C	RS8024	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) RUNIC classify the MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F. Please align with RUNIC if your end application is quite critical to the preconditioning setting or if you have special requirement.

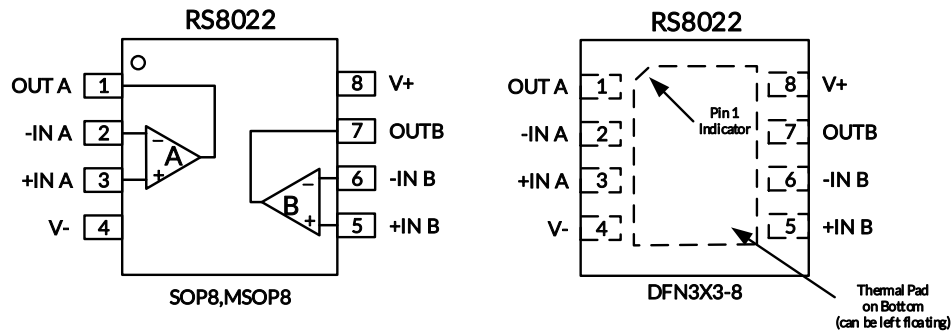
6 PIN CONFIGURATION AND FUNCTIONS



PIN DESCRIPTION

NAME	PIN			I/O ⁽¹⁾	DESCRIPTION
	RS8021	RS8021B	RS8021		
	SOT23-5	SOT23-5	SOP8/MSOP8		
-IN	4	3	2	I	Negative (inverting) input
+IN	3	1	3	I	Positive (noninverting) input
NC	-	-	1,5,8	-	No internal connection (can be left floating)
OUT	1	4	6	O	Output
V-	2	2	4	-	Negative (lowest) power supply
V+	5	5	7	-	Positive (highest) power supply

(1) I = Input, O = Output.

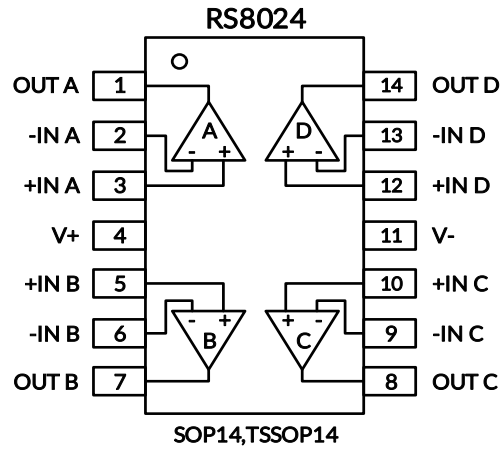


PIN DESCRIPTION

NAME	PIN	I/O ⁽¹⁾	DESCRIPTION
	SOP8/MSOP8/DFN3X3-8		
-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
V+	8	-	Positive (highest) power supply
-	Thermal Pad	-	Connect thermal pad to V-

(1) I = Input, O = Output.

PIN CONFIGURATION AND FUNCTIONS



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
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, $V_S = (V+) - (V-)$			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⁾		-55	55	mA
	Output short-circuit ⁽⁴⁾		Continuous		
θ_{JA}	Package thermal impedance ⁽⁵⁾	SOT23-5		230	°C/W
		SOP8		110	
		MSOP8		170	
		SOP14		105	
		TSSOP14		90	
		DFN3X3-8		45	
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 ± 55 mA or less.

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

(5) The package thermal impedance is calculated in accordance with JEDEC-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)	± 5000	V
		Machine Model (MM)	± 400	



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	1.4		5.5	V
	Dual-supply	± 0.7		± 2.75	

7.4 Electrical Characteristics

(At $T_A = +25^\circ\text{C}$, $V_S = 5.0\text{V}$, $R_L = 1\text{M}\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, Full⁽⁹⁾ = -40°C to 125°C , unless otherwise noted.)⁽¹⁾

PARAMETER		CONDITIONS	T _J	RS8021, RS8022, RS8024			
				MIN ⁽²⁾	TYP ⁽³⁾	MAX ⁽²⁾	UNIT
POWER SUPPLY							
V _S	Operating Voltage Range		25°C	1.4		5.5	V
I _Q	Quiescent Current Per Amplifier		25°C		400	1000	nA
PSRR	Power-Supply Rejection Ratio	V _S =2.5V to 5.5V, V _{CM} =(V ₋)+0.5V	25°C	62	70		dB
INPUT							
V _{OS}	Input Offset Voltage	V _{CM} =V _S /2	25°C	-3	±0.5	3	mV
V _{OS} T _C	Input Offset Voltage Average Drift	V _{CM} =V _S /2	Full		±2.3		µV/°C
I _B	Input Bias Current ⁽⁴⁾ ⁽⁵⁾		25°C	-10	±1	10	pA
I _{OS}	Input Offset Current ⁽⁴⁾		25°C	-10	±1	10	pA
V _{CM}	Common-Mode Voltage Range	V _S = 5.5V	25°C	-0.1		5.6	V
CMRR	Common-Mode Rejection Ratio	V _S = 5.5V, V _{CM} =-0.1V to 4V	25°C	73	90		dB
		V _S = 5.5V, V _{CM} =-0.1V to 5.6V	25°C	60	83		dB
OUTPUT							
A _{OL}	Open-Loop Voltage Gain	V _S =1.4V, R _L =50KΩ, V _O =V _S -0.1V	25°C	85	102		dB
		V _S =5.0V, R _L =50kΩ, V _O =V _S -0.1V	25°C	92	106		dB
	Output Swing From Rail	R _L =50KΩ	25°C		5		mV
I _{OUT}	Output Short-Circuit Current ⁽⁶⁾ ⁽⁷⁾		25°C		8		mA
FREQUENCY RESPONSE							
SR	Slew Rate ⁽⁸⁾		25°C		1.5		V/ms
GBP	Gain-Bandwidth Product		25°C		5		kHz
PM	Phase Margin		25°C		60		°
NOISE							
e _n p-p	Input Voltage Noise	f = 0.1 Hz to 10 Hz	25°C		4.5		µVpp
e _n	Input Voltage Noise Density	f = 1 kHz	25°C		360		nV/√Hz

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 $T_{J(\text{MAX})}$, $R_{\theta JA}$, 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 $T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $R_L = 1\text{M}\Omega$ connected to $V_S/2$, $C_L = 60\text{pF}$ $V_{CM} = V_S/2$, unless otherwise noted.

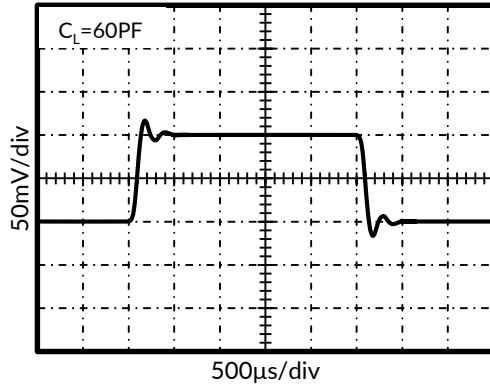


Figure 1. Small-Signal Step Response

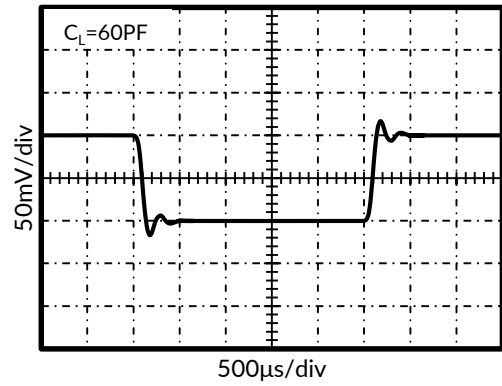


Figure 2. Small-Signal Step Response

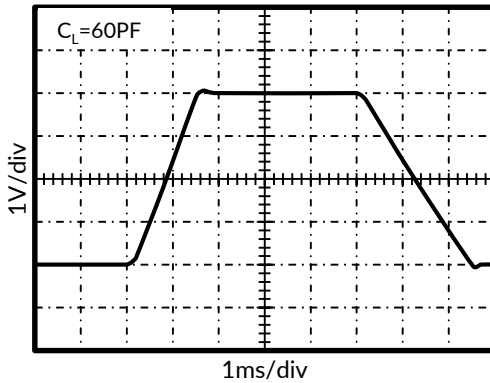


Figure 3. Large-Signal Step Response

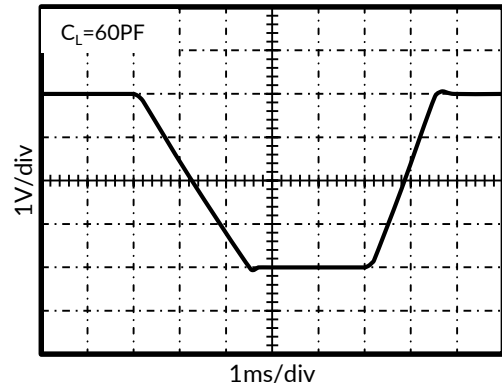


Figure 4. Large-Signal Step Response

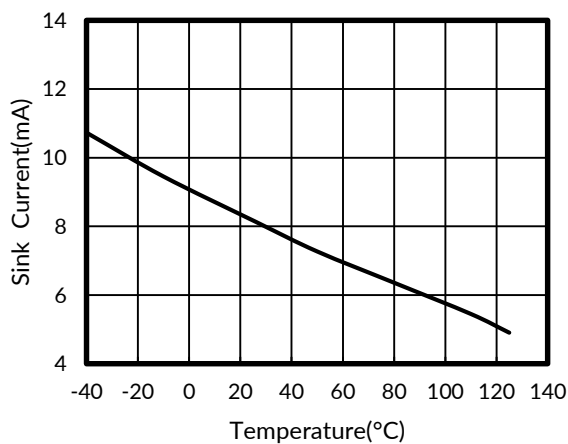


Figure 5. Sink Current vs Temperature

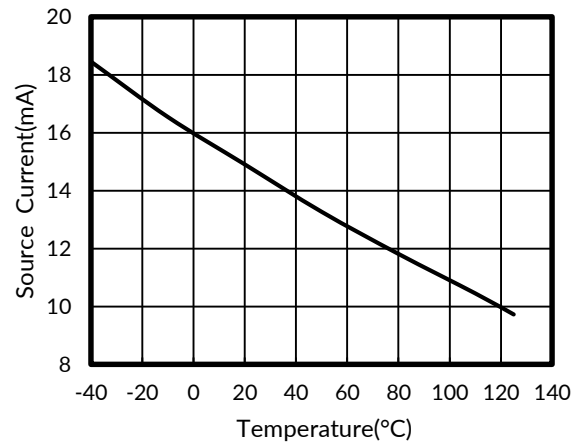
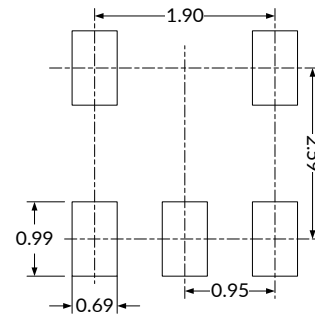
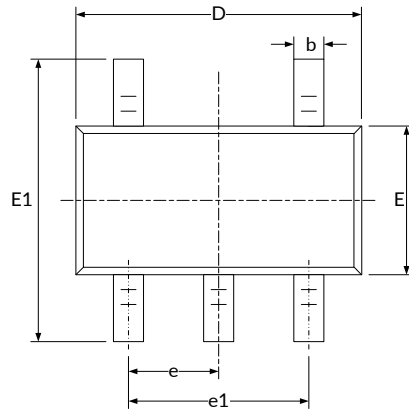


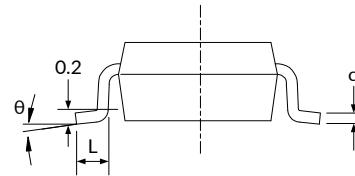
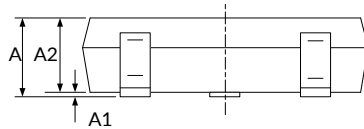
Figure 6. Source Current vs Temperature

8 PACKAGE OUTLINE DIMENSIONS

SOT23-5⁽³⁾



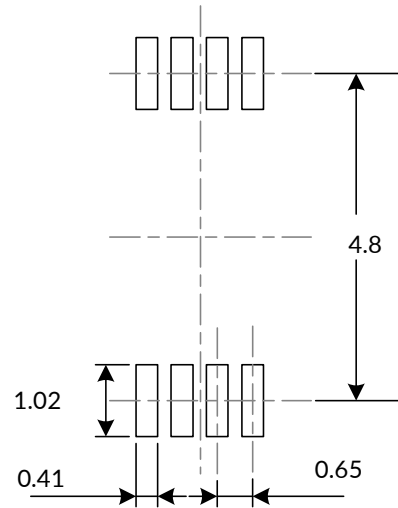
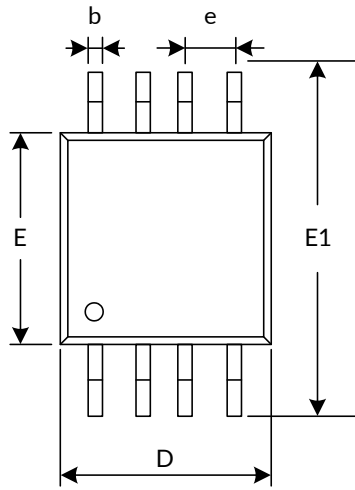
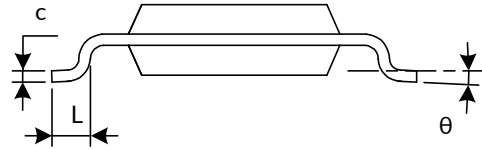
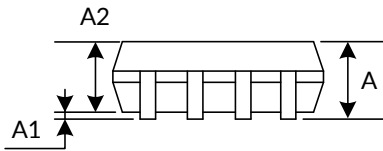
RECOMMENDED LAND PATTERN (Unit: mm)



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:

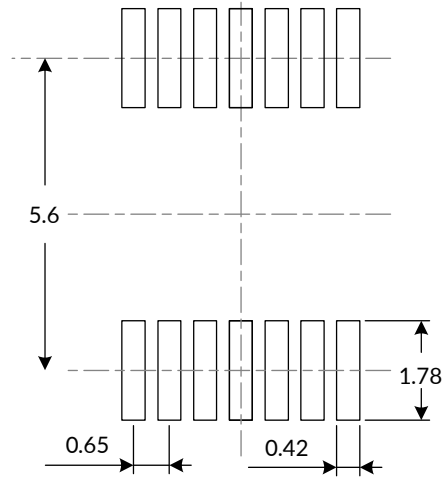
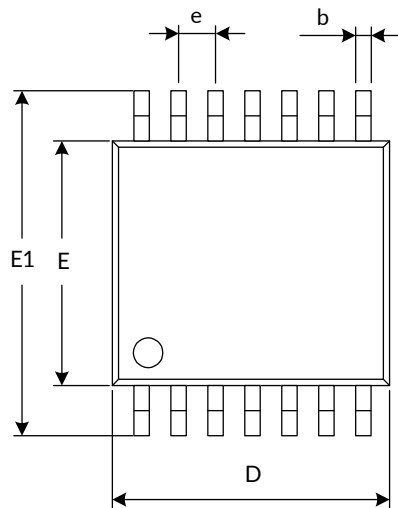
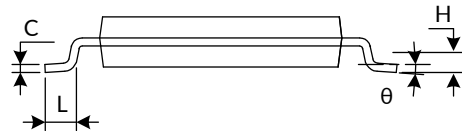
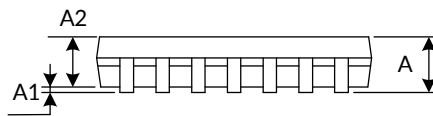
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

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
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D ⁽¹⁾	2.900	3.100	0.114	0.122
e	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:

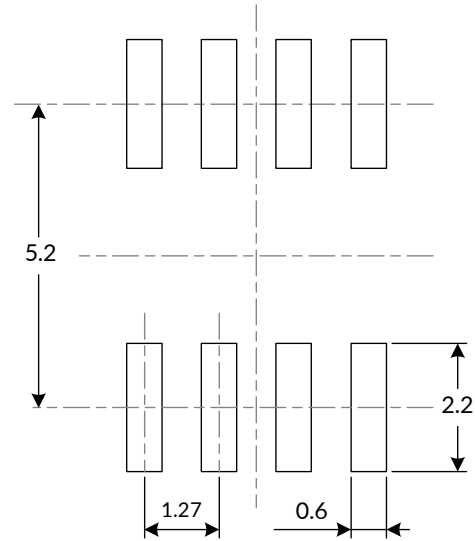
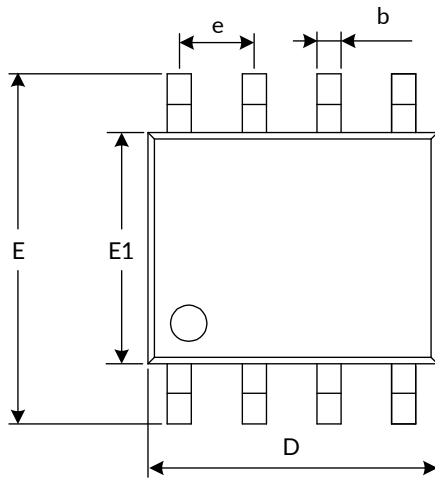
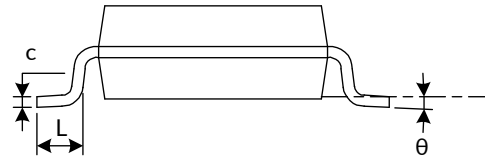
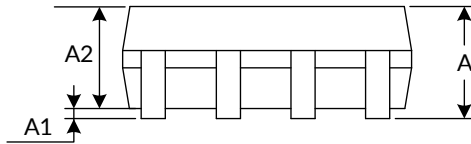
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TSSOP14⁽³⁾

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	0.250(TYP)		0.010(TYP)	
θ	1°	7°	1°	7°

NOTE:

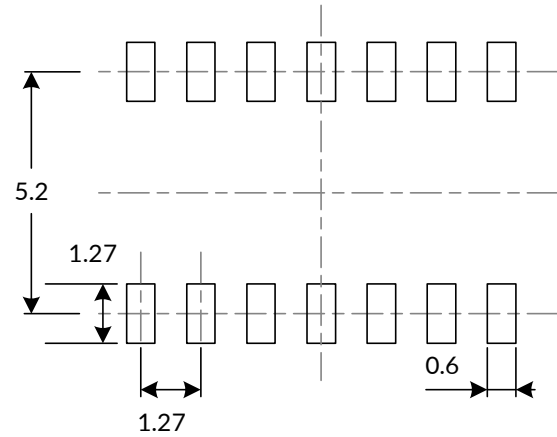
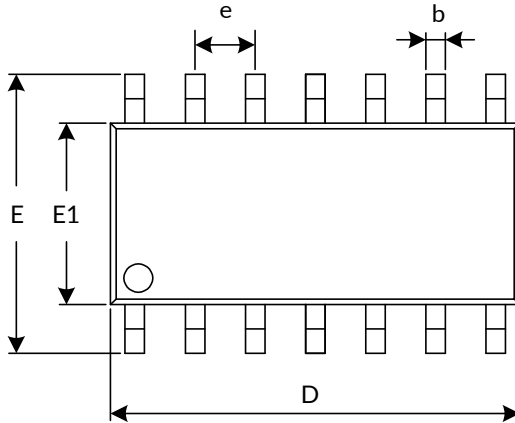
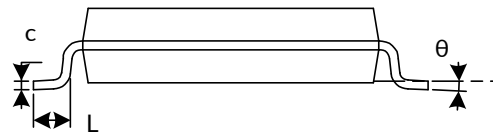
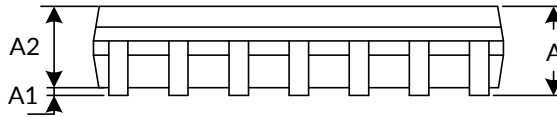
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

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:

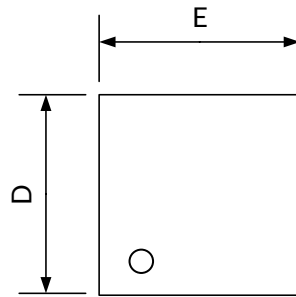
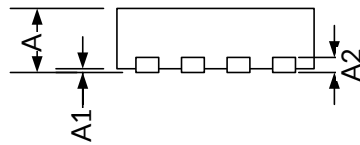
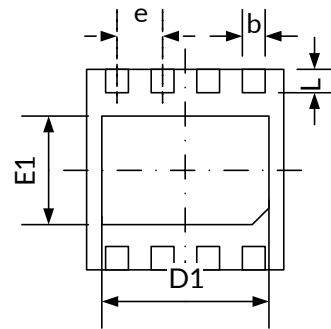
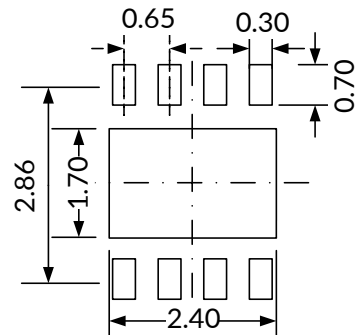
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

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.

DFN3X3-8⁽²⁾

TOP VIEW

SIDE VIEW

BOTTOM VIEW

RECOMMENDED LAND PATTERN (Unit: mm)

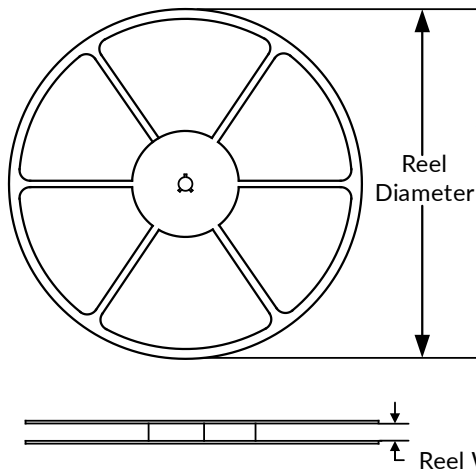
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A ⁽¹⁾	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203		0.008	
b	0.250	0.350	0.010	0.014
D ⁽¹⁾	2.900	3.100	0.114	0.122
D1	2.350	2.450	0.093	0.096
E ⁽¹⁾	2.900	3.100	0.114	0.122
E1	1.650	1.750	0.065	0.069
e	0.650 TYP		0.026 TYP	
L	0.370	0.470	0.015	0.019

NOTE:

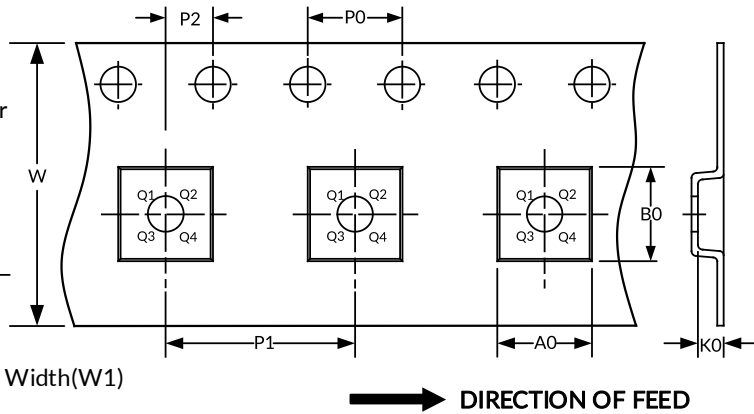
1. Plastic or metal protrusions of 0.075mm maximum per side are not included.
2. This drawing is subject to change without notice.

9 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
MSOP8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
TSSOP14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
SOP8	13"	12.4	6.40	5.40	2.10	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
DFN3X3-8	13"	12.4	3.35	3.35	1.13	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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