

36V, 1.2MHz Rail-to-Rail Output CMOS Operational Amplifier

1 FEATURES

- **High Gain Bandwidth: 1.2MHz**
- **Input Offset Voltage: $\pm 1.5\text{mV}$ (Max at 25°C)**
- **Quiescent Current: 150 μA /Amp**
- **Rail to Rail Output**
- **Common-Mode Input Voltage Range Include Ground**
- **Supply Range: +3V to +36V**
- **Specified Up to +125°C**
- **Micro Size Packages: SOT23-5**

2 APPLICATIONS

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

3 DESCRIPTIONS

The RS841XP families of products offer high voltage (36V) operation and rail-to-rail output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (1.2MHz) and slew rate of 0.67V/ μs . The op-amps are unity gain stable and feature an ultra-low input bias current.

The devices are stable at capacitance up to 300pF. The input can operate normally within 100mV below of the negative power rail to 2V below of the positive power rail. The RS841XP 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 36V or dual power supplies of $\pm 1.5\text{V}$ to $\pm 18\text{V}$.

Device Information ⁽¹⁾

| PART NUMBER | PACKAGE | BODY SIZE(NOM) |
|-------------|---------|-----------------|
| RS8411P | SOT23-5 | 2.90mm x 1.60mm |
| RS8412P | SOP8 | 4.90mm x 3.90mm |
| | MSOP8 | 3.00mm x 3.00mm |
| RS8414P | SOP14 | 8.65mm x 3.90mm |

(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 | 2020/12/4 | Initial version completed |
| A.2 | 2021/6/21 | 1. Fix TSSOP-14 Package mistake in Page 12 in A.1 Version 2. Added the value of Input Voltage Noise Density 3. Added the information of package size 4. Updated IQ values in Page 8 in A.1 Version |
| A.3 | 2022/03/16 | Increase the minimum junction temperature |
| A.4 | 2024/01/24 | 1. Add MSL in Page 7 in A.3 Version 2. Updated ELECTRICAL CHARACTERISTICS values in Page 8 in A.3 Version |
| A.4.1 | 2024/03/01 | Modify packaging naming |
| A.5 | 2024/12/23 | Delete RS8411PXF/RS8414PXQ Orderable Device |

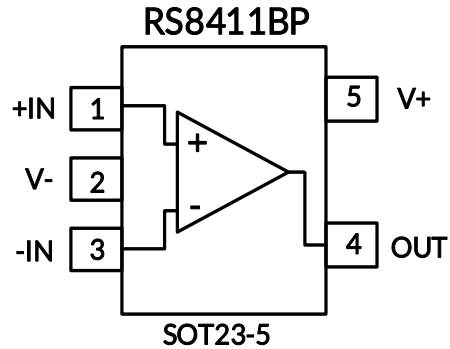
5 PACKAGE/ORDERING INFORMATION ⁽¹⁾

| Orderable Device | Package Type | Pin | Channel | Op Temp(°C) | Device Marking ⁽²⁾ | MSL ⁽³⁾ | Package Qty |
|------------------|--------------|-----|---------|--------------|-------------------------------|--------------------|--------------------|
| RS8411BPXF | SOT23-5 | 5 | 1 | -40°C ~125°C | 8411BP | MSL3 | Tape and Reel,3000 |
| RS8412P XK | SOP8 | 8 | 2 | -40°C ~125°C | RS8412P | MSL3 | Tape and Reel,4000 |
| RS8412PXM | MSOP8 | 8 | 2 | -40°C ~125°C | RS8412P | MSL3 | Tape and Reel,4000 |
| RS8414PXP | SOP14 | 14 | 4 | -40°C ~125°C | RS8414P | 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

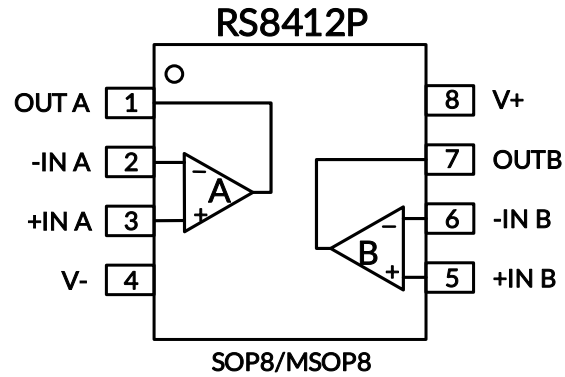


Pin Description

| NAME | PIN | I/O ⁽¹⁾ | DESCRIPTION |
|------|----------|--------------------|--|
| | RS8411BP | | |
| +IN | 1 | I | Positive (noninverting) input |
| V- | 2 | - | Negative (lowest) power supply or ground (for single supply operation) |
| -IN | 3 | I | Negative (inverting) input |
| OUT | 4 | O | Output |
| V+ | 5 | - | Positive (highest) power supply |

(1) I = Input, O = Output.

PIN CONFIGURATION AND FUNCTIONS

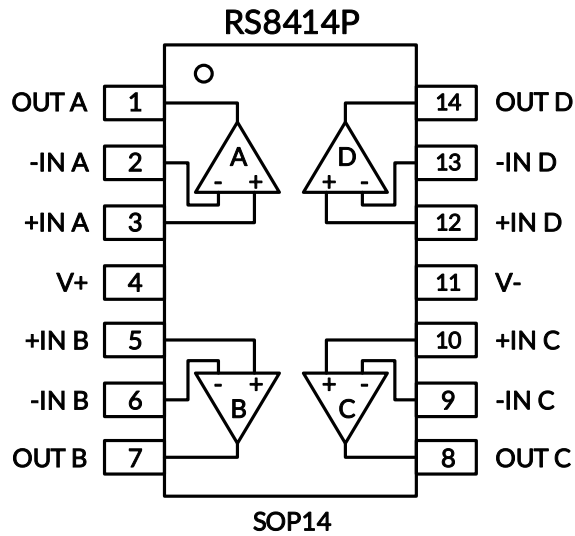


Pin Description

| 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



Pin Description

| NAME | PIN | I/O ⁽¹⁾ | DESCRIPTION |
|------|-------|--------------------|--|
| | SOP14 | | |
| -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-circuit ⁽⁴⁾ | Continuous | | | |
| θ_{JA} | Package thermal impedance ⁽⁵⁾ | SOT23-5 | | 230 | °C/W |
| | | SOP8 | | 110 | |
| | | MSOP8 | | 170 | |
| | | SOP14 | | 105 | |
| 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 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) | ± 5000 |
| | | Machine Model (MM) | ± 200 |

(1) JEDEC document JEP155 states that 500-V HBM 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 | | 36 | V |
| | Dual-supply | ± 1.5 | | ± 18 | |

7.4 Electrical Characteristics

(At $T_A = +25^\circ\text{C}$, $V_S = 3\text{V}$ to 36V , $R_L = 10\text{k}\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, $V_{CM} = V_S/2$, Full ⁽⁹⁾ = -40°C to 125°C , unless otherwise noted.) ⁽¹⁾

| PARAMETER | | CONDITIONS | T_J | RS841XP | | | UNITS |
|---------------------------|--|--|--------------------|--------------------|--------------------|--------------------|------------------------------|
| | | | | MIN ⁽²⁾ | TYP ⁽³⁾ | MAX ⁽²⁾ | |
| POWER SUPPLY | | | | | | | |
| V_S | Operating Voltage Range | | 25°C | 3 | | 36 | V |
| I_Q | Quiescent Current Per Amplifier | $V_S = \pm 2.5\text{V}$, $I_O = 0\text{mA}$ | 25°C | | 150 | 350 | μA |
| | | $V_S = \pm 18\text{V}$, $I_O = 0\text{mA}$ | | | 200 | 450 | |
| PSRR | Power-Supply Rejection Ratio | $V_S = 5\text{V}$ to 36V | 25°C | 95 | 120 | | dB |
| INPUT | | | | | | | |
| V_{OS} | Input Offset Voltage | $V_{CM} = V_S/2$ | 25°C | -1.5 | ± 0.5 | 1.5 | mV |
| | | | Full | | ± 0.8 | | |
| V_{OS} T_C | Input Offset Voltage Average Drift | | Full | | 3 | | $\mu\text{V}/^\circ\text{C}$ |
| I_B | Input Bias Current ^{(4) (5)} | $V_{CM} = 0\text{V}$ | 25°C | | 10 | 60 | pA |
| | | | Full | | 600 | | |
| I_{OS} | Input Offset Current ⁽⁵⁾ | $V_{CM} = 0\text{V}$ | 25°C | | 10 | 60 | pA |
| | | | Full | | 600 | | |
| V_{CM} | Common-Mode Voltage Range | $V_S = \pm 18\text{V}$ | 25°C | (V-)-0.1 | | (V+)-2 | V |
| CMRR | Common-Mode Rejection Ratio | $V_S = \pm 2.5\text{V}$, $V_{CM} = (\text{V-}) - 0.1\text{V}$ to $(\text{V+}) - 2\text{V}$ | 25°C | 70 | 110 | | dB |
| | | $V_S = \pm 18\text{V}$, $V_{CM} = (\text{V-}) - 0.1\text{V}$ to $(\text{V+}) - 2\text{V}$ | 25°C | 70 | | | |
| OUTPUT | | | | | | | |
| A_{OL} | Open-Loop Voltage Gain | $R_L = 10\text{k}\Omega$, $V_O = (\text{V-}) + 0.6\text{V}$ to $(\text{V+}) - 0.6\text{V}$ | 25°C | 83 | 115 | | dB |
| V_{OH} | Output Swing | $V_S = \pm 18\text{V}$, $R_L = 10\text{k}\Omega$ | 25°C | 17.85 | | | V |
| V_{OL} | | | | | | -17.85 | |
| I_{SC} | Short-circuit current ^{(6) (7)} | | 25°C | ± 35 | ± 80 | | mA |
| C_{LOAD} | Capacitive load drive | | 25°C | | 100 | | pF |
| FREQUENCY RESPONSE | | | | | | | |
| SR | Slew Rate ⁽⁸⁾ | $G = +1$, $C_L = 100\text{pF}$ | 25°C | | 0.67 | | $\text{V}/\mu\text{s}$ |
| GBW | Gain-Bandwidth Product | | 25°C | | 1.2 | | MHz |
| t_s | Settling Time, 0.01% | $V_S = \pm 2.5\text{V}$, $G = +1$, $C_L = 100\text{pF}$, Step = 2V | 25°C | | 5 | | μs |
| t_{OR} | Overload Recovery Time | $V_{IN} \cdot \text{Gain} \geq V_S$, $G = 11$ | 25°C | | 5 | | μs |
| t_{ON} | Turn On Time | | 25°C | | 10 | | μs |
| NOISE | | | | | | | |
| E_n | Input Voltage Noise | $f = 0.1\text{Hz}$ to 10Hz , $V_S = \pm 2.5\text{V}$ | 25°C | | 16 | | μV_{pp} |
| e_n | Input Voltage Noise Density | $f = 1\text{KHz}$ | 25°C | | 45 | | $\text{nV}/\sqrt{\text{Hz}}$ |

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) 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 $T_{J(MAX)}$, $R_{\theta JA}$, and T_A . The maximum allowable power dissipation at any ambient temperature is $PD = (T_{J(MAX)} - T_A) / R_{\theta JA}$. 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 $T_A = +25^\circ\text{C}$, $V_S = \pm 18\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{OUT} = V_S/2$, unless otherwise noted.

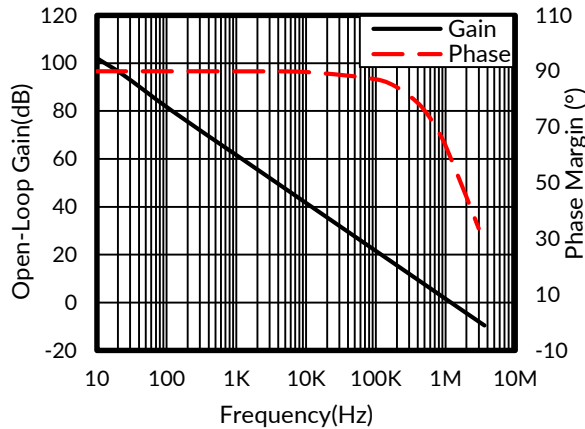


Figure 1. Open-Loop Gain and Phase vs Frequency

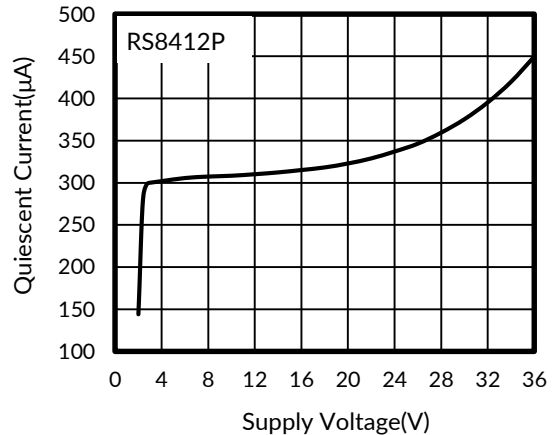


Figure 2. Supply Voltage vs Quiescent Current

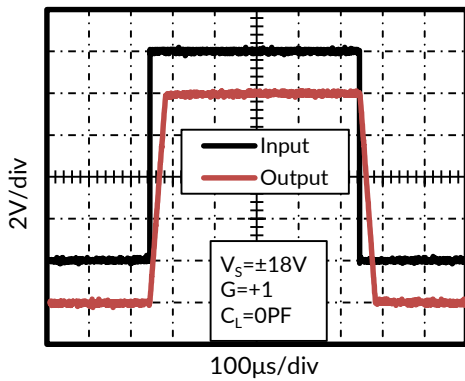


Figure 3. Large Signal Step Response

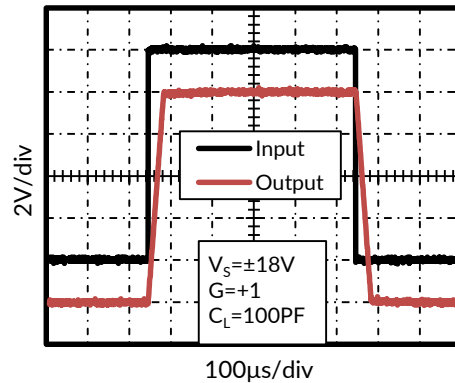


Figure 4. Large Signal Step Response

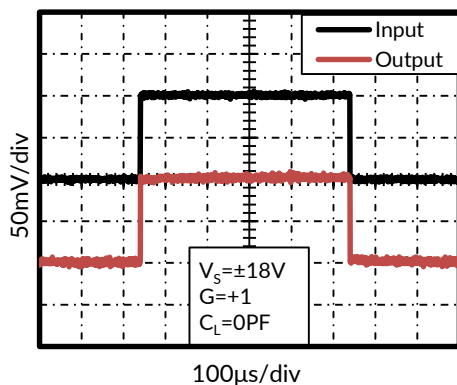


Figure 5. Small Signal Step Response

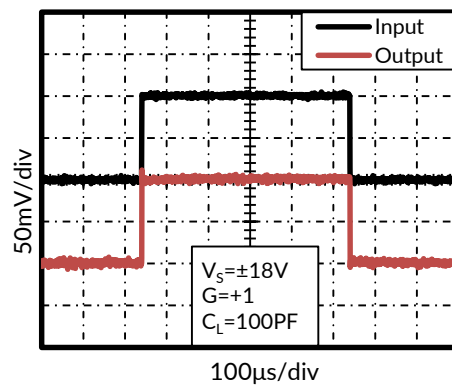


Figure 6. Small Signal Step Response

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 $T_A = +25^\circ\text{C}$, $V_S = \pm 18\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{OUT} = V_S/2$, unless otherwise noted.

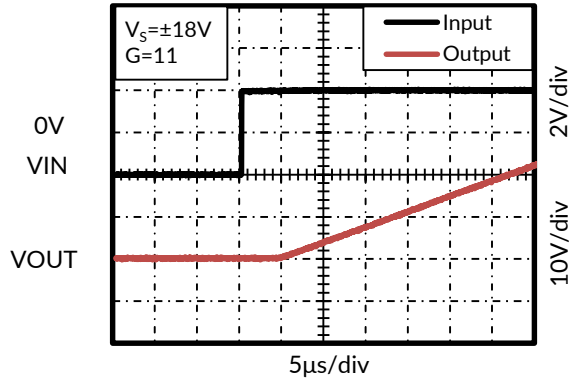


Figure 7. Positive Overvoltage Recovery

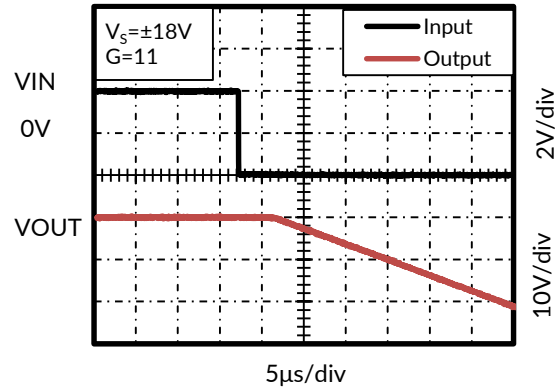


Figure 8. Negative Overvoltage Recovery

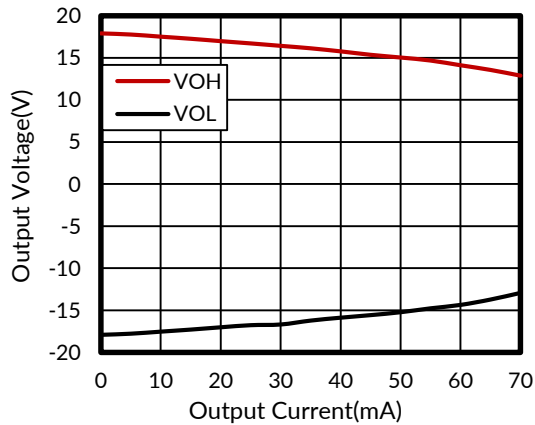


Figure 9. Output Voltage Swing vs Output Current

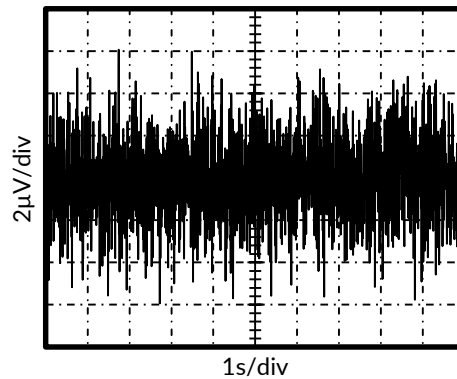
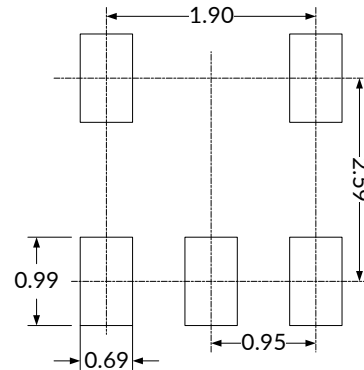
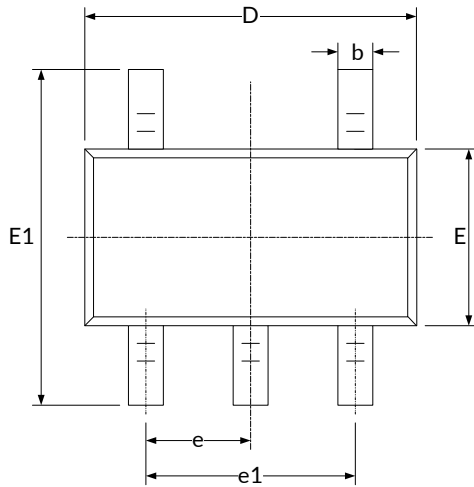
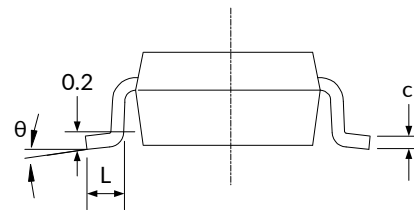
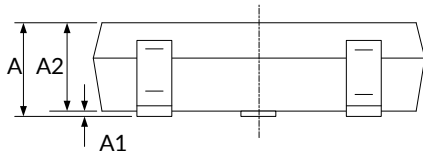


Figure 10. 0.1Hz to 10Hz Noise at $V_S = 5\text{V}$

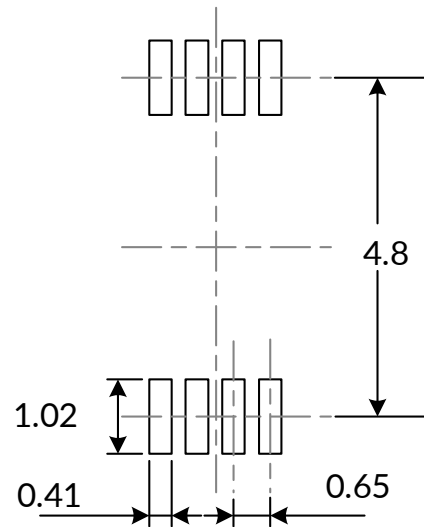
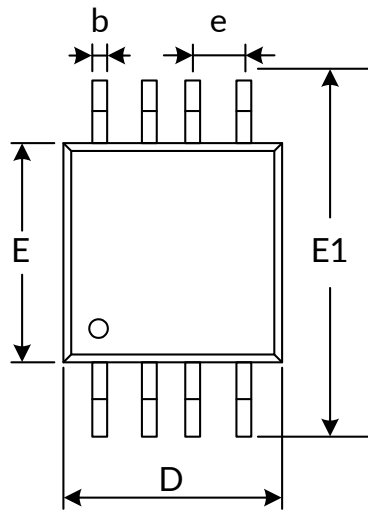
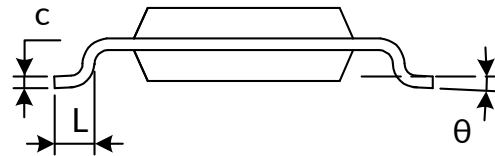
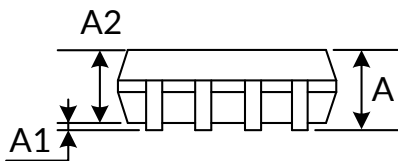
8 PACKAGE OUTLINE DIMENSIONS SOT23-5⁽³⁾


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:

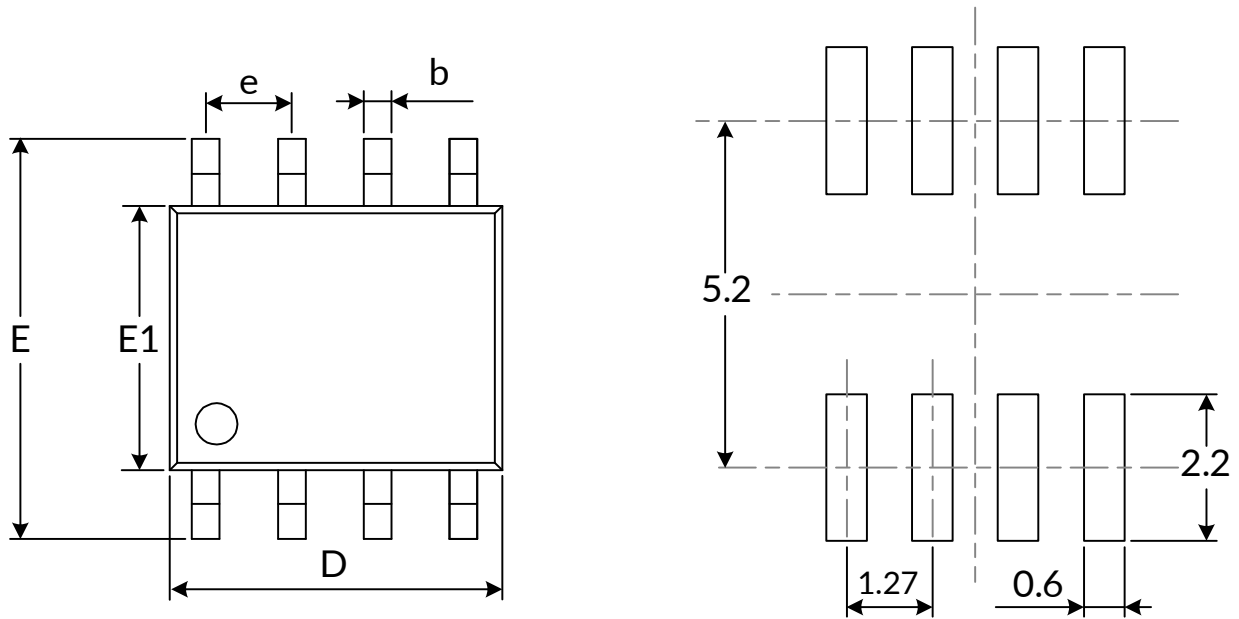
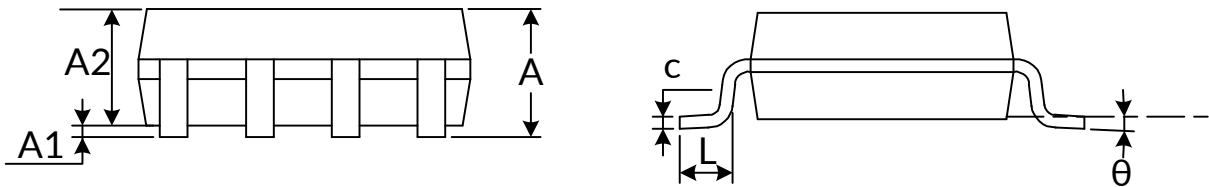
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

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:

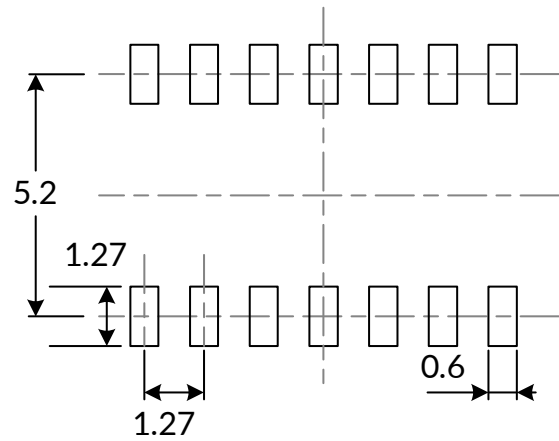
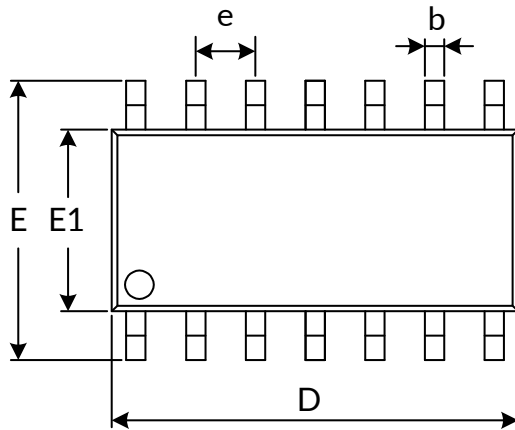
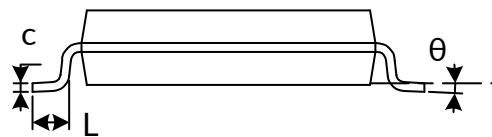
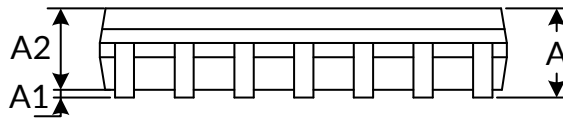
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

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° |

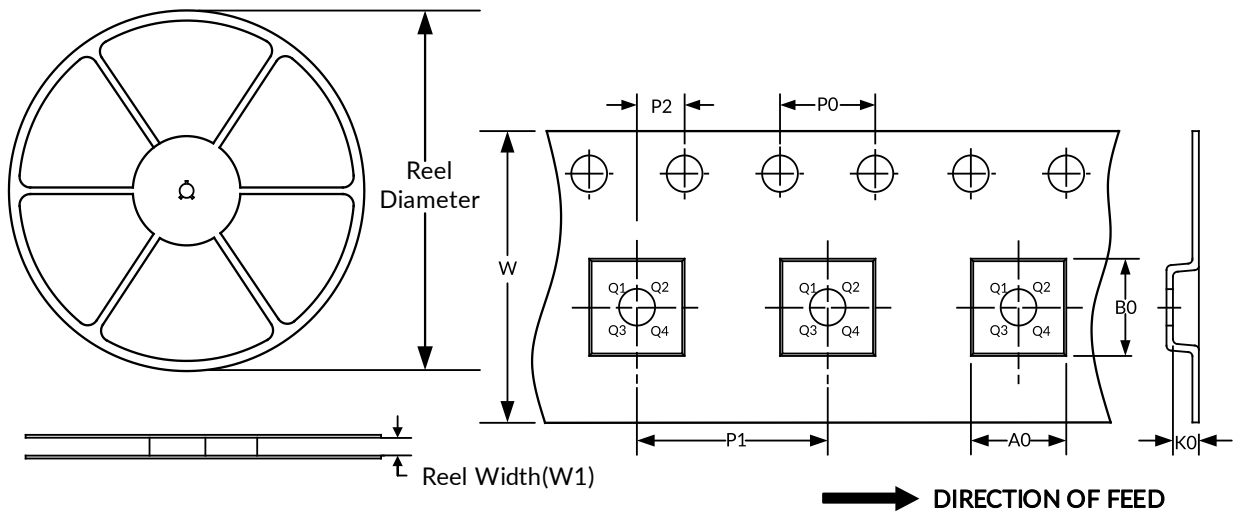
NOTE:

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.

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 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 |

NOTE:

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

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