

1MHz, Rail-to-Rail I/O CMOS Operational Amplifiers

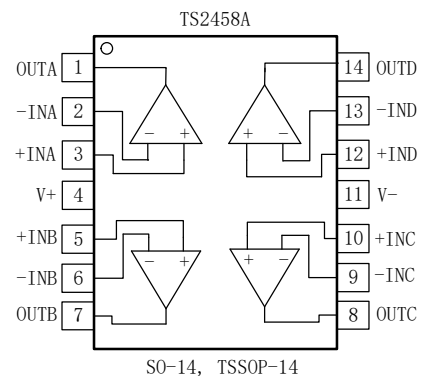
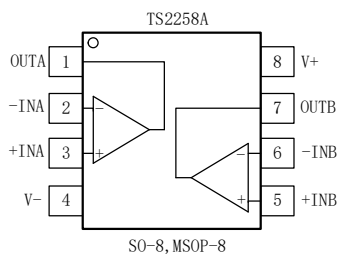
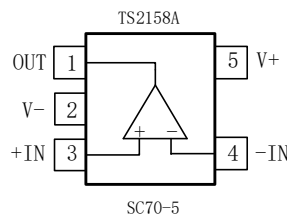
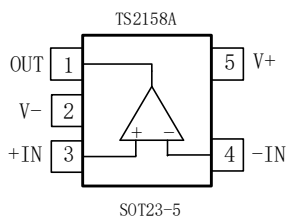
FEATURES

- RAIL-TO-RAIL INPUT/OUTPUT
- HIGH SLEW RATE: 1V/μs
- LOW INPUT BIAS CURRENT: 1pA typ at 25°C
- GAIN BANDWIDTH PRODUCT: 1 MHz
- LOW OFFSET VOLTAGE DRIFT: 3μV/°C typ
- LOW POWER CONSUMPTION: 90μA per amplifier at 5 V
- LOW SUPPLY VOLTAGE: 2.5 V ~ 5.5 V (25°C)
- EXTENDED TEMPERATURE: -40°C to +125°C

APPLICATIONS

- BATTERY-POWERED APPLICATIONS
- PORTABLE DEVICES
- SIGNAL CONDITIONING
- ACTIVE FILTERING
- CURRENT SENSOR AMPLIFIER
- WEIGHT SCALE SENSOR
- MEDICAL/ INDUSTRIAL INSTRUMENTATION
- INSTRUMENTATION

PIN ASSIGNMENTS



GENERAL DESCRIPTION

TS2158A/TS2258A/TS2458A are the most cost-effective amplifiers for low voltage, low power consumption and low-cost applications. The rail-to-rail output and rail-to-rail inputs that exceed power supply range make the TS2158A series easy to use for very low voltage supply applications.

Low I_B feature of these amplifiers allows the parts to be ideal for many sensor applications. 1MHz GBW and 1V/μs slew rate under low power supply voltage can meet almost all sensor requirement.

Small Packages:

TS2158A in a SOT23-5 and SC70-5

TS2258A in a SO8 and MSOP8

TS2458A in a SO14 and TSSOP14

ORDERING INFORMATION

| Model | Part Number | Eco Plan | Package | AMP | Container, Pack Qty |
|---------|-----------------|----------|----------|-----|---------------------|
| TS2158A | TS2158ASOT235R | Rohs | SOT23-5 | 1 | Reel, 3000 |
| TS2158A | TS2158ASC705R | Rohs | SC70-5 | 1 | Reel, 2500 |
| TS2258A | TS2258ASO8R | Rohs | SO-8 | 2 | Reel, 2500 |
| TS2258A | TS2258AMSOP8R | Rohs | MSOP-8 | 2 | Reel, 2500 |
| TS2458A | TS2458ASO14R | Rohs | SO-14 | 4 | Reel, 2500 |
| TS2458A | TS2458ATSSOP14R | Rohs | TSSOP-14 | 4 | Reel, 2500 |

ABSOLUTE MAXIMUM RATINGS

| Parameter | Min | Max | Unit |
|-----------------------------------|------------|------------|------|
| Supply Voltage | | 7.0 | V |
| Signal Input Terminal Voltage | (V-) - 0.5 | (V+) + 0.5 | V |
| Operating Temperature | -50 | 150 | °C |
| Junction Temperature | | 150 | °C |
| Storage Temperature | -65 | 150 | °C |
| Lead Temperature (Soldering, 10s) | | 260 | °C |
| ESD HBM | | ±3000 | V |
| ESD MM | | ±400 | V |
| ESC CDM | | ±1000 | V |

ESD CAUTION



ESD (Electrostatic Discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjects to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

ELECTRICAL CHARACTERISTICS

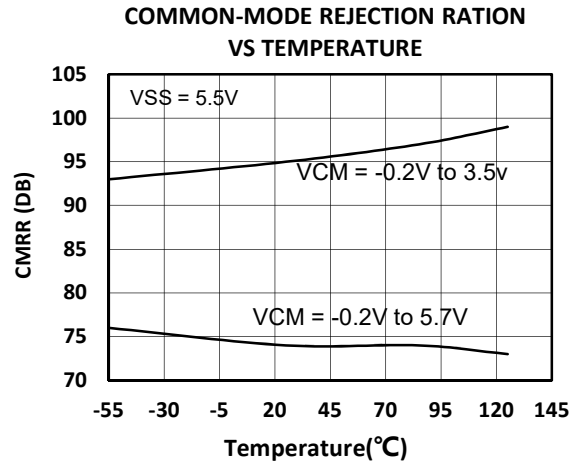
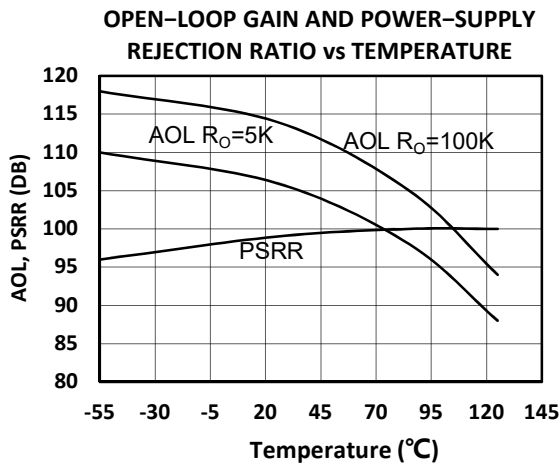
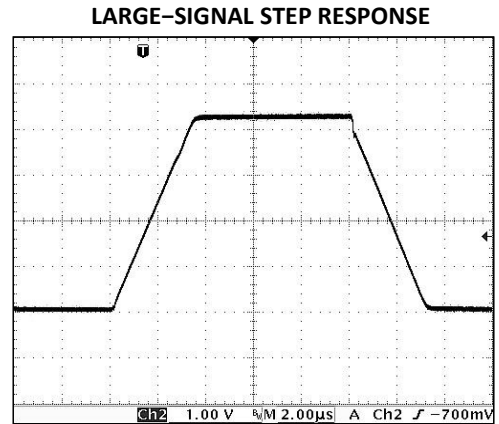
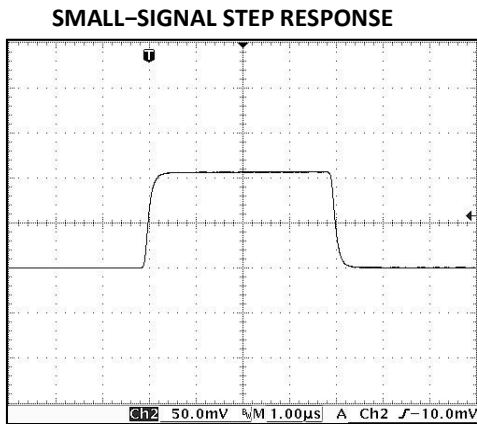
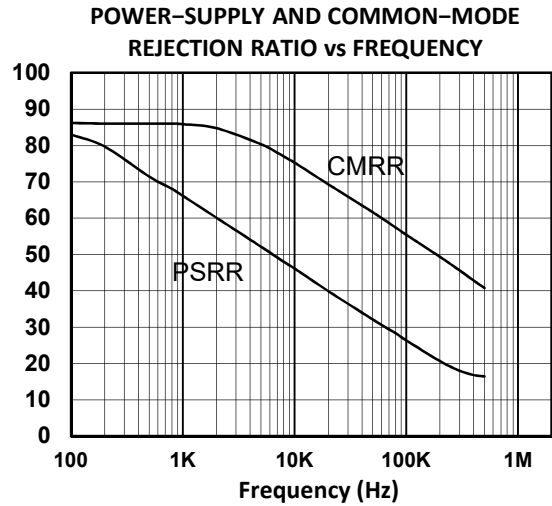
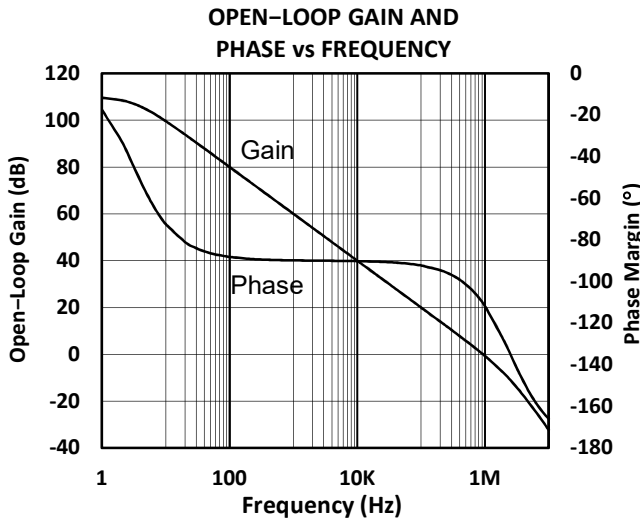
$V_S = +2.5V$ to $+5.5V$, at $T_A = +25^\circ C$, $R_L = 100k\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.

Boldface limits apply over the specified temperature range, $T_A = -40^\circ C$ to $+125^\circ C$.

| Symbol | Parameter | Operating Conditions | Min | Typ | Max | Unit |
|----------------------------------|--|--|---|----------------|-----|--------------------------|
| Input Characteristics | | | | | | |
| V_{OS} dV_{OS}/dT | Input Offset Voltage Drift | $V_S = 5V$ | | 1 3 | 3.5 | mV $\mu V/^\circ C$ |
| CMRR | Common Mode Rejection Ratio $T_A = -40^\circ C$ to $+125^\circ C$ $T_A = -40^\circ C$ to $+125^\circ C$ | $(V_-) - 0.2V < V_{CM} < (V_+) - 2V$ $(V_-) - 0.2V < V_{CM} < (V_+) - 2V$ $V_S = 5.5V, (V_-) - 0.2V < V_{CM} < (V_+) + 0.2V$ $V_S = 5.5V, (V_-) - 0.2V < V_{CM} < (V_+) + 0.2V$ | 73 65 60 56 | 87 72 | | dB dB dB dB |
| I_B I_{OS} | Input Bias Current Input Offset Current | | | 1 1 | | pA pA |
| PSRR | Power Supply Rejection Ratio $T_A = -40^\circ C$ to $+125^\circ C$ | $V_S = 2.5V$ to $V_S = 5.5V, V_{CM} < (V_+) - 2V$ | 75 68 | 90 | | dB dB |
| A_{OL} | Open-Loop Gain $T_A = -40^\circ C$ to $+125^\circ C$ Open-Loop Gain $T_A = -40^\circ C$ to $+125^\circ C$ | $V_S = 5V, R_L = 5k\Omega, 0.125V < V_O < 4.875V$ $V_S = 5V, R_L = 5k\Omega, 0.125V < V_O < 4.875V$ $V_S = 5V, R_L = 100k\Omega, 0.025V < V_O < 4.975V$ $V_S = 5V, R_L = 100k\Omega, 0.025V < V_O < 4.975V$ | 96 70 101 76 | 102 110 | | dB dB dB dB |
| Output Characteristics | | | | | | |
| | Output Voltage Swing from Rail | $R_L = 100k\Omega$ | | 10 | | mV |
| R_{OUT} | Open-Loop Output Impedance | $f = 1MHz, I_o = 0$ | | 280 | | Ω |
| Frequency Domain Response | | | | | | |
| GBW | Gain Bandwidth Product | | | 1 | | MHz |
| t_s | Settling Time to 0.1% | $V_{OUT} = 2V$ step; $G = +1$ | | 3 | | μs |
| | Overload recovery time | $V_{in} * Gain > V_S$ | | 1 | | μs |
| SR | Slew Rate | $G = +1$ | | 1 | | V/ μs |
| Distortion/Noise Response | | | | | | |
| THD+N | Total Harmonic Distortion+ Noise | $V_S = 5V, V_o = 3V_{pp}, G = +1, f = 1kHz$ | | TBD | | % |
| e_n | Input Voltage Noise Density | $f = 10kHz$ | | 40 | | nV/ \sqrt{Hz} |
| V_{NOISE} | Input Voltage Noise | $f = 0.1Hz$ to $10Hz$ | | 6.5 | | μV_{pp} |
| Power Supply | | | | | | |
| V_S | Specified Voltage Range | | 2.5 | | 5.5 | V |
| | Operating Voltage Range | | 2.2 | | 5.5 | V |
| I_S | Supply Current | $I_o = 0, V_S = 5V$ | | 90 | 132 | μA |
| Temperature Range | | | | | | |
| θ_{JA} | Specified Range Thermal Resistance SO-8 | | -40 | | 125 | $^\circ C$ |
| | | | | 150 | | $^\circ C/W$ |

TYPICAL CHARACTERISTICS

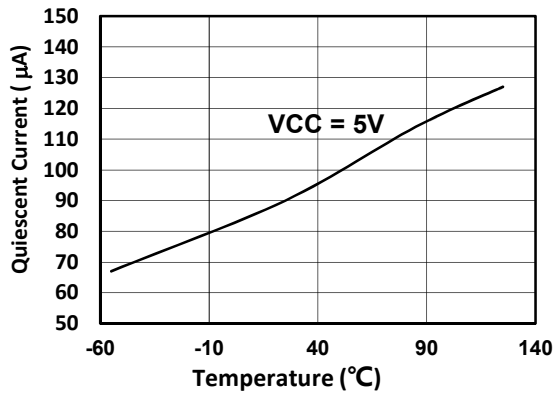
At $T_A = +25^\circ\text{C}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.



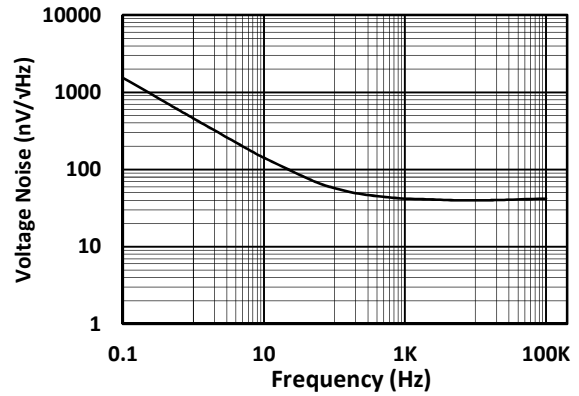
TYPICAL CHARACTERISTICS

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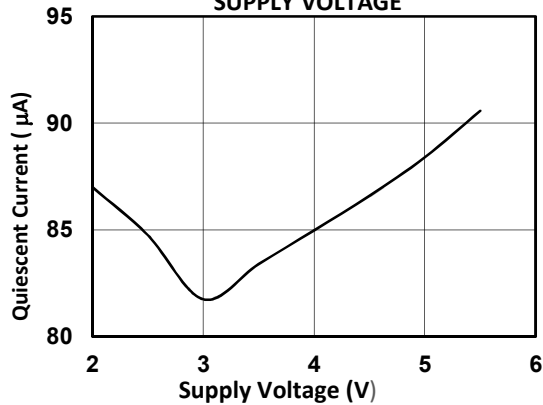
QUIESCENT CURRENT VS TEMPERATURE



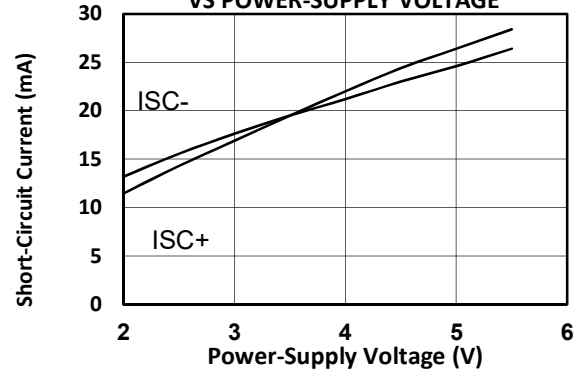
INPUT VOLTAGE NOISE
SPECTRAL DENSITY VS FREQUENCY



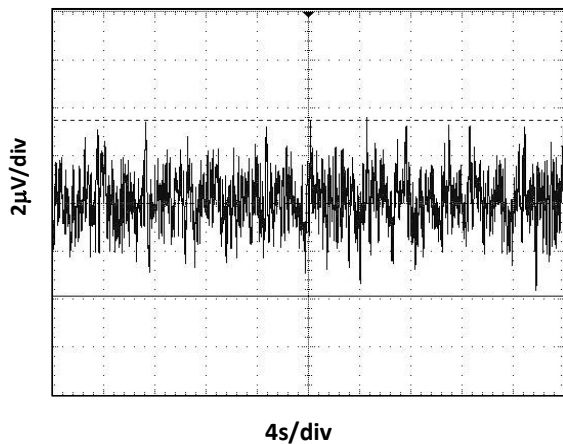
QUIESCENT CURRENT VS
SUPPLY VOLTAGE



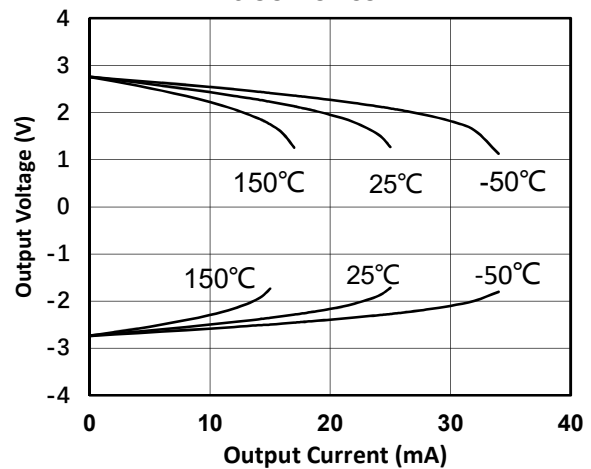
CONTINUOUS SHORT-CIRCUIT CURRENT
VS POWER-SUPPLY VOLTAGE



0.1 TO 10HZ NOISE



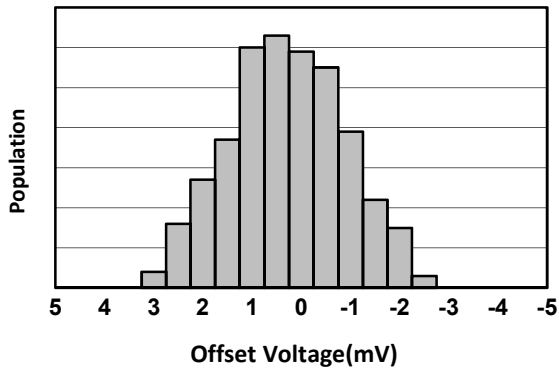
OUTPUT VOLTAGE SWING
VS OUTPUT CURRENT



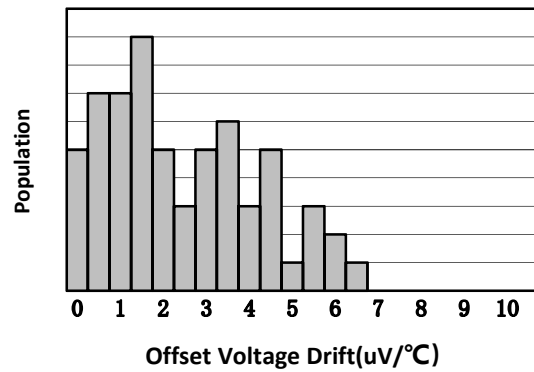
TYPICAL CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $R_L = 10\text{k}\Omega$ connected to $V_s/2$, and $V_{OUT} = V_s/2$, unless otherwise noted.

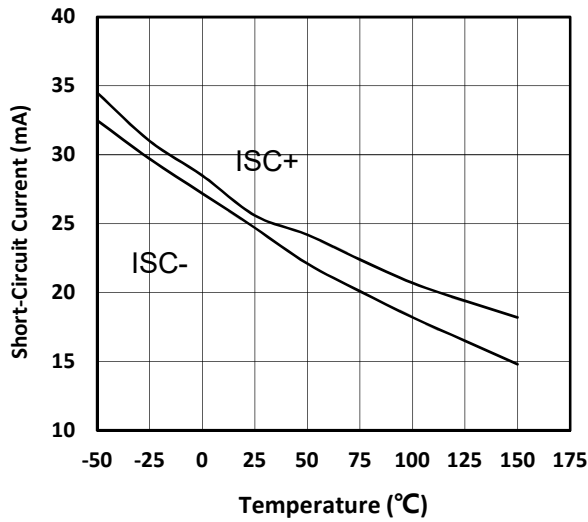
Offset Voltage Production Distribution



Offset Voltage Drift Magnitude Production Distribution

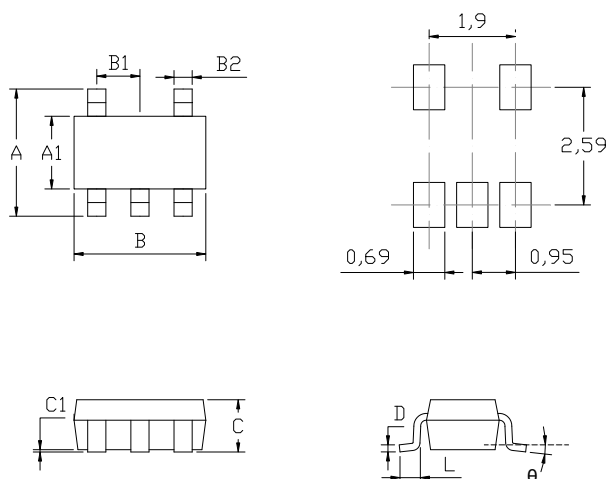


SHORT-CIRCUIT CURRENT VS TEMPERATURE



MECHANICAL DIMENSIONS

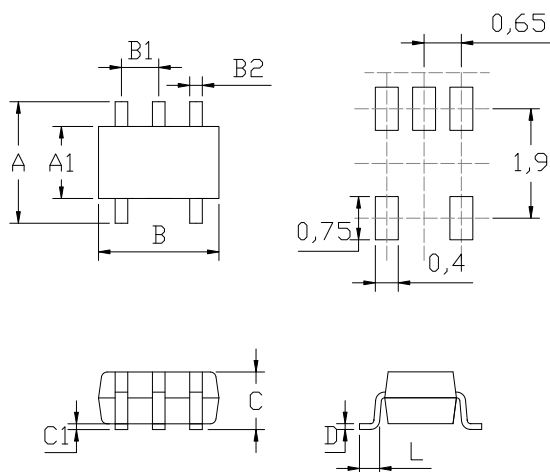
SOT23-5 PACKAGE MECHANICAL DRAWING



SOT23-5 PACKAGE MECHANICAL SPECIFICATIONS

| symbol | dimensions | | | |
|----------|-------------|---------|--------|-----------|
| | millimeters | | inches | |
| | min | max | min | max |
| A | 2.6 | 3 | 0.1024 | 0.1181 |
| A1 | 1.45 | 1.75 | 0.0571 | 0.0689 |
| B | 2.75 | 3.05 | 0.1083 | 0.1201 |
| B1 | 0.95 | | 0.0374 | |
| B2 | 0.3 | 0.5 | 0.0118 | 0.0197 |
| C | | 1.45MAX | | 0.0571MAX |
| C1 | 0 | 0.15 | 0.0000 | 0.0059 |
| L | 0.3 | 0.5 | 0.0118 | 0.0197 |
| D | 0.08 | 0.22 | 0.0031 | 0.0087 |
| θ | 0° | 8° | 0° | 8° |

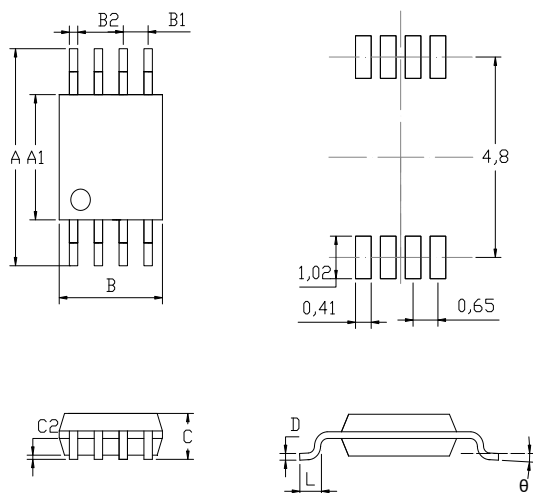
SC70-5 PACKAGE MECHANICAL DRAWING



SC70-5 PACKAGE MECHANICAL SPECIFICATIONS

| symbol | dimensions | | | |
|--------|-------------|--------|--------|-----------|
| | millimeters | | inches | |
| | min | max | min | max |
| A | 1.8 | 2.4 | 0.0709 | 0.0945 |
| A1 | 1.1 | 1.4 | 0.0433 | 0.0551 |
| B | 2.15 | 1.85 | 0.0846 | 0.0728 |
| B1 | 0.95 | | 0.0374 | |
| B2 | 0.15 | 0.3 | 0.0059 | 0.0118 |
| C | | 1.1MAX | | 0.0433MAX |
| C1 | 0 | 0.10 | 0.0000 | 0.0039 |
| L | 0.26 | 0.46 | 0.0102 | 0.0181 |
| D | 0.08 | 0.22 | 0.0031 | 0.0087 |
| θ | 0° | 8° | 0° | 8° |

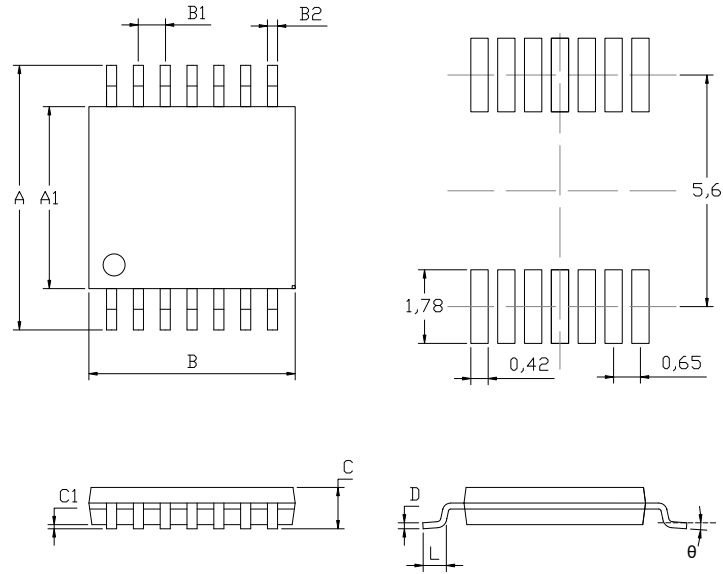
MSOP-8 PACKAGE MECHANICAL DRAWING



MSOP-8 PACKAGE MECHANICAL SPECIFICATIONS

| symbol | dimensions | | | |
|----------|-------------|---------|--------|--------|
| | millimeters | | inches | |
| | min | max | min | max |
| A | 4.75 | 5.05 | 0.1870 | 0.1988 |
| A1 | 2.9 | 3.1 | 0.1142 | 0.1220 |
| B | 2.9 | 3.1 | 0.1142 | 0.1220 |
| B1 | 0.65 | | 0.0197 | |
| B2 | 0.17 | 0.3 | 0.0067 | 0.0106 |
| C | | 1.10MAX | | 0.0433 |
| C1 | 0.05 | 0.15 | 0.0020 | 0.0059 |
| L | 0.4 | 0.7 | 0.0157 | 0.0276 |
| D | 0.13 | 0.23 | 0.0051 | 0.0091 |
| θ | 0° | 8° | 0° | 8° |

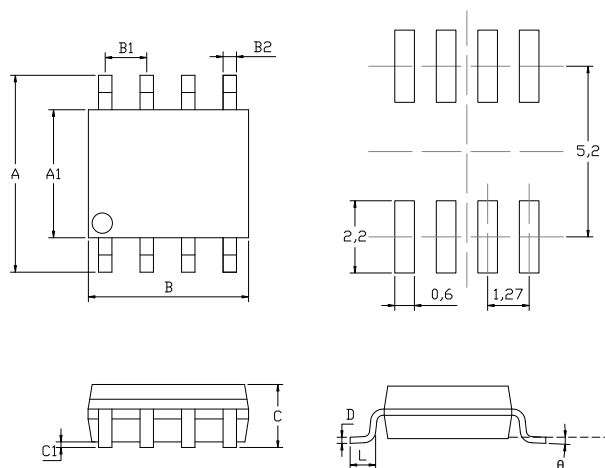
TSSOP-14 PACKAGE MECHANICAL DRAWING



TSSOP-14 PACKAGE MECHANICAL SPECIFICATIONS

| symbol | dimensions | | | |
|--------|-------------|---------|--------|-----------|
| | millimeters | | inches | |
| | min | max | min | max |
| A | 6.2 | 6.6 | 0.2441 | 0.2598 |
| A1 | 4.3 | 4.5 | 0.1693 | 0.1772 |
| B | 4.9 | 5.1 | 0.1929 | 0.2008 |
| B1 | 0.65 | | 0.0256 | |
| B2 | 0.19 | 0.3 | 0.0075 | 0.0118 |
| C | | 1.20MAX | | 0.0472MAX |
| C1 | 0.05 | 0.15 | 0.0020 | 0.0059 |
| L | 0.5 | 0.75 | 0.0197 | 0.0295 |
| D | 0.1 | 0.2 | 0.0039 | 0.0079 |
| θ | 0° | 8° | 0° | 8° |

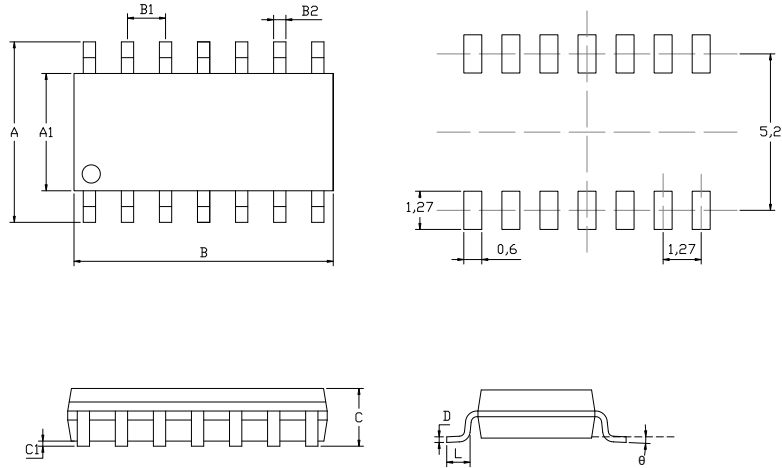
SO-8 PACKAGE MECHANICAL DRAWING



SO-8 PACKAGE MECHANICAL SPECIFICATIONS

| symbol | dimensions | | | |
|--------|-------------|---------|--------|-----------|
| | millimeters | | inches | |
| | min | max | min | max |
| A | 5.8 | 6.2 | 0.2283 | 0.2441 |
| A1 | 3.8 | 4 | 0.1496 | 0.1575 |
| B | 4.8 | 5 | 0.1890 | 0.1969 |
| B1 | 1.27 | | 0.0500 | |
| B2 | 0.31 | 0.51 | 0.0122 | 0.0201 |
| C | | 1.75MAX | | 0.0689MAX |
| C1 | 0.1 | 0.25 | 0.0039 | 0.0098 |
| L | 0.4 | 1.27 | 0.0157 | 0.0500 |
| D | 0.13 | 0.25 | 0.0051 | 0.0098 |
| theta | 0° | 8° | 0° | 8° |

SO-14 PACKAGE MECHANICAL DRAWING



SO-14 PACKAGE MECHANICAL SPECIFICATIONS

| symbol | dimensions | | | |
|--------|-------------|------|--------|--------|
| | millimeters | | inches | |
| | min | max | min | max |
| A | 6.2 | 5.8 | 0.2441 | 0.2283 |
| A1 | 3.8 | 4 | 0.1496 | 0.1575 |
| B | 8.55 | 8.75 | 0.3366 | 0.3445 |
| B1 | 1.27 | | 0.0500 | |
| B2 | 0.31 | 0.51 | 0.0122 | 0.0201 |
| C | 1.75MAX | | | 0.0689 |
| C1 | 0.1 | 0.25 | 0.0039 | 0.0098 |
| L | 0.4 | 1.27 | 0.0157 | 0.0500 |
| D | 0.13 | 0.25 | 0.0051 | 0.0098 |
| θ | 0° | 8° | 0° | 8° |

CONTACT INFORMATION

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