# WS72042

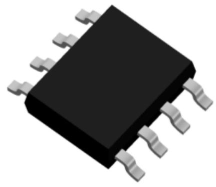
## 600nA Nano-Power Rail-to-Rail Input Output Operational Amplifiers

Http://www.willsemi.com

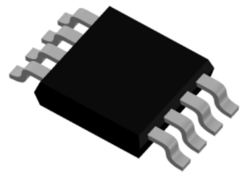
### Descriptions

The WS72042 is a dual low-voltage operational amplifier with rail-to-rail input/output swing. Ultra low power makes this amplifier ideal for battery-powered and portable applications. The WS72042 has a gain-bandwidth product of 29kHz (TYP) and is unity gain stable. These specifications make this operational amplifier appropriate for low frequency applications, such as battery current monitoring and sensor conditioning.

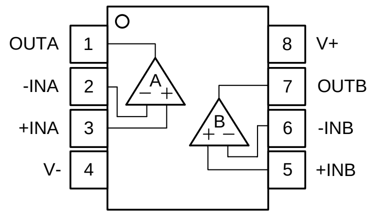
WS72042 is available with MSL 3 Level in SOP-8L package and MSOP-8L package. Standard products are Pb-Free and halogen-Free.



SOP-8L



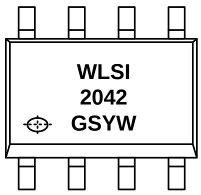
MSOP-8L



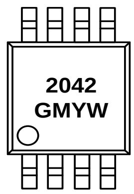

**SOP-8L/MSOP-8L**
**Pin configuration (Top view)**

### Applications

- Handsets and Mobile Accessories
- Current Sensing
- Wireless Remote Sensors,Active RFID Readers
- Environment/Gas/Oxygen Sensors
- Threshold Detectors/Discriminators
- Low Power Filters
- Battery or Solar Powered Devices
- Sensor Network Powered by Energy Scavenging




SOP-8L




MSOP-8L

**Marking**

**2042 = Device code**
**GS = Special code**
**GM = Special code**
**Y = Year code**
**W = Week code**

### Features

- Wide Supply Voltage : 1.6~5.5V
- Quiescent Current per Amplifier : 610nA Typical
- GBWP : 29kHz
- Rail-to-Rail Input/Output Swing
- Unity Gain Stable
- -40˚C to 85˚C Operation Temperature Range
- Available in Green SOP-8L and MSOP-8L Packages

### Order Information

| Device | Package | Shipping |
|---|---|---|
| WS72042S-8/TR | SOP-8L | 4000/Reel &Tape |
| WS72042M-8/TR | MSOP-8L | 4000/Reel &Tape |

## Pin Descriptions

| Pin Number | Symbol | Descriptions |
|---|---|---|
| 1 | OUTA | Output |
| 2 | -INA | Inverting input |
| 3 | +INA | Non-inverting input |
| 4 | V- | Negative supply |
| 5 | +INB | Non-inverting input |
| 6 | -INB | Inverting input |
| 7 | OUTB | Output |
| 8 | V+ | Positive supply |

## Absolute Maximum Ratings[1]

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Supply Voltage, ([V+] - [V-]) | $V_S$[2] | 6 | V |
| Input Common Mode Voltage Range | $V_{ICR}$ | $(V^-)$-0.3 to $(V^+)$+0.3 | V |
| Output Short-Circuit Duration | $t_{SO}$[3] | Unlimited | / |
| Operating Fee-Air Temperature Range | $T_A$ | -40 to 125 | ℃ |
| Storage Temperature Range | $T_{STG}$ | -65 to 150 | ℃ |
| Junction Temperature Range | $T_J$ | 150 | ℃ |
| Lead Temperature Range | $T_L$ | 260 | ℃ |

**Note:**

1. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are only stress ratings, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions are not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2. All voltage values, except differential voltage are with respect to network terminal.
3. A heat sink may be required to keep the junction temperature below the absolute maximum.This depends on the power supply voltage and how many amplifiers are shorted.Thermal resistance varies the amount of PC board metal connected to the package.The specified values are for short traces connected to the leads.

## ESD, Electrostatic Discharge Protection

| Symbol | Parameter | Condition | Minimum level | Unit |
|---|---|---|---|---|
| HBM | Human Body Model ESD | MIL-STD-883H Method 3015.8<br>JEDEC-EIA/JESD22-A114A | ±8000 | V |
| CDM | Charged Device Model ESD | JEDEC-EIA/JESD22-C101E | ±2000 | V |
| MM | Machine Model ESD | JEDEC-EIA/JESD22-A115 | ±400 | V |

## Electronics Characteristics

The *denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A$ = 27°C. $V_S$ = 5V, $V_{CM}$ = $V_{OUT}$ = $V_S/2$, $R_{load}$ = 100kΩ, $C_{load}$ = 60pF, $V_{SHDN}$ is unconnected.

| Symbol | Parameter | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{OS}$ | Input Offset Voltage | $V_{CM}$= $V_S$/2 and $V_{CM}$=GND | * | -3.0 | ±0.1 | 3.0 | mV |
| $α_{VOS}$ | Input Offset Voltage Drift | | | | 2.8 | | μV/°C |
| $I_{IB}$ | Input Bias Current | | | | <10 | | pA |
| $I_{OS}$ | Input Offset Current | | | | <10 | | pA |
| $V_n$ | Input Voltage Noise | f=0.1Hz to10Hz | | | 5 | | $μV_{P-P}$ |
| $e_n$ | Input Voltage Noise Density | f=1kHz | | | 125 | | nV/√Hz |
| $R_{IN}$ | Input Resistance | | | | >1 | | TΩ |
| CMRR | Common Mode Rejection Ratio | $V_{CM}$=0.1V to 4.9V | * | 55 | 74 | | dB |
| $V_{CM}$ | Common Mode Input Voltage Range | | * | $(V^-)$-0.3 | | $(V^+)$+0.3 | V |
| PSRR | Power Supply Rejection Ratio | | * | 60 | 86 | | dB |
| $A_{VOL}$ | Open Loop Large Signal Gain | $V_{OUT}$=2.5V,$R_{load}$=100kΩ | | 80 | 120 | | dB |
| | | $V_{OUT}$=0.1V to 4.9V, $R_{load}$=100kΩ | * | 80 | 120 | | dB |
| $V_{OL}$,$V_{OH}$ | Output Swing from Supply Rail | $R_{load}$=100kΩ | | | 3 | | mV |
| $R_{OUT}$ | Closed-Loop Output Impedance | G=1,f=1kHz,$I_{OUT}$=0 | | | 0.7 | | Ω |
| $I_{SC}$ | Output Short-Circuit Current | Sink or Source Current | | 12 | 20 | | mA |
| $V_{DD}$ | Supply Voltage | | | 1.6 | | 5.5 | V |
| $I_Q$ | Quiescent Current per Amplifier | | * | | 610 | 760 | nA |
| PM | Phase Margin | $R_{load}$=100kΩ, $C_{load}$=60pF | | | 80 | | degrees |
| GM | Gain Margin | $R_{load}$=100kΩ, $C_{load}$=60pF | | | 18 | | dB |
| GBWP | Gain-Bandwidth Product | f=1kHz | | | 29 | | kHz |
| $t_S$ | Settling Time: 1.5 to 3.5V, Unity Gain | 0.1% | | | 0.18 | | ms |
| | Settling Time: 2.45 to 2.55V, Unity Gain | 0.1% | | | 0.02 | | ms |
| SR | Slew Rate | $A_V$=1, $V_{OUT}$=1.5V to 3.5V, $R_{load}$=100kΩ, $C_{load}$=60pF | | | 9 | | mV/μs |
| FPBW | Full Power Bandwidth[Note1] | $2V_{P-P}$ | | | 600 | | Hz |

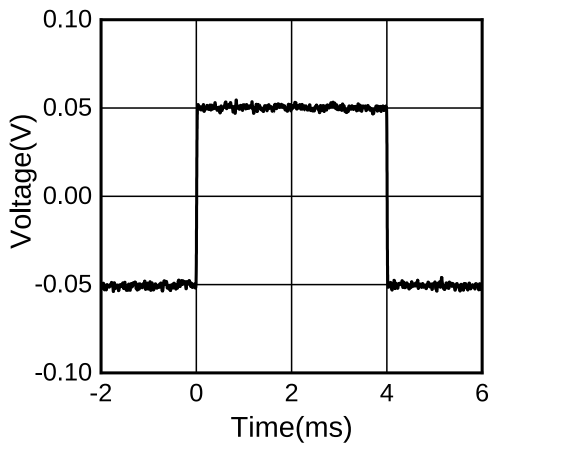
**Note:**

1. Full power bandwidth is calculated from the slew rate FPBW = SR/(π • $V_{P-P}$).

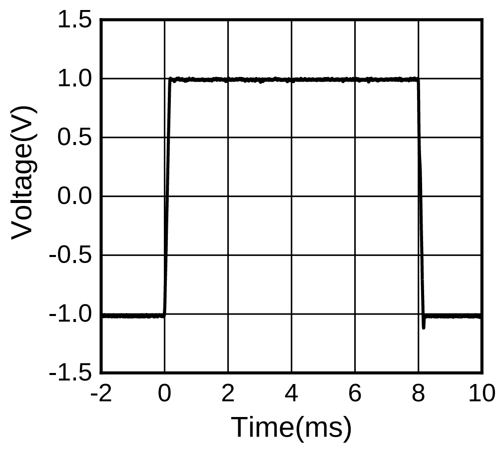
## Typical Characteristics

**$T_A$=25°C, $V_S$=5V, $V_{CM}$=$V_S$/2, unless otherwise noted**

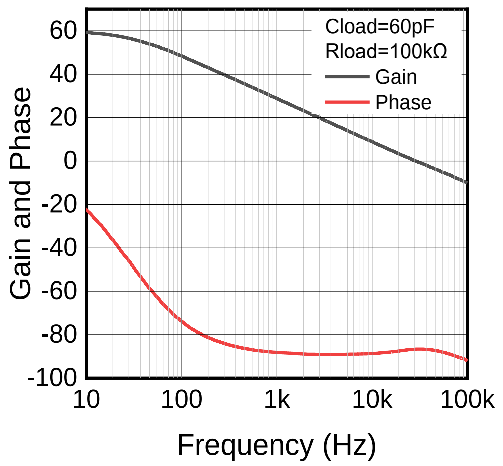
**Small-Siganl Step Response, 100mV Step**



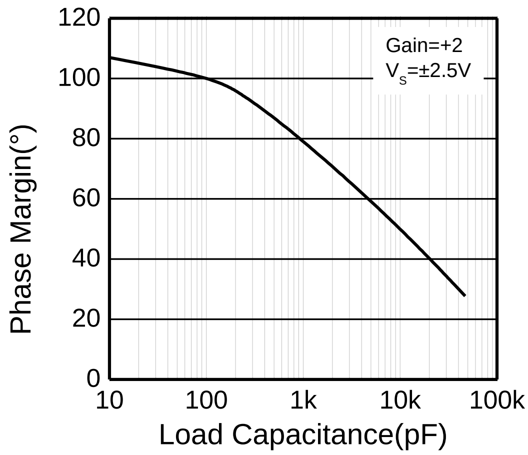

**Large-Siganl Step Response, 2V Step**



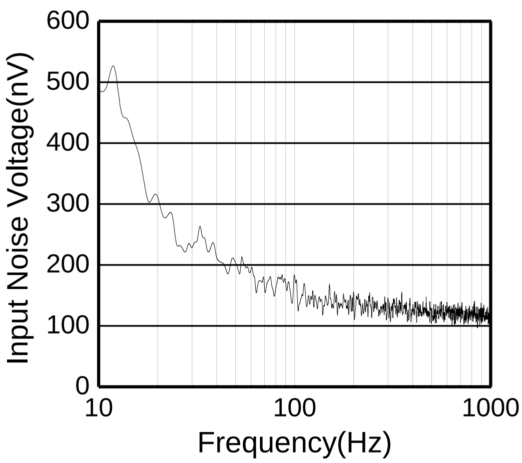

**Open-Loop Gain and Phase**



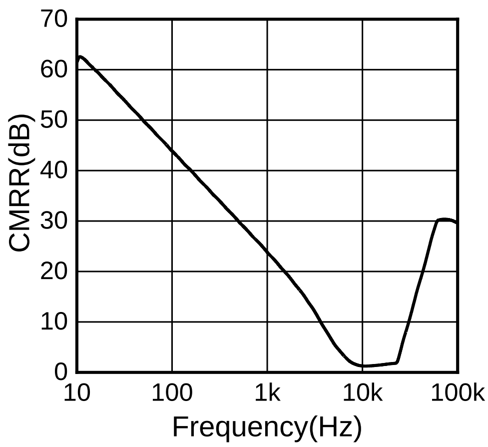

**Phase Margin vs. $C_{load}$ (Stable for Any $C_{load}$)**




**Input Voltage Noise Spectral Density**




**CMRR vs. Frequency**

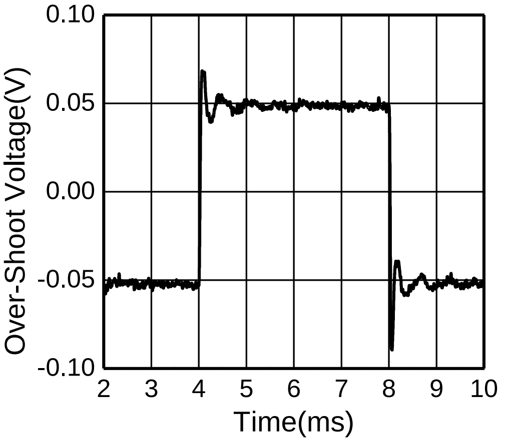


## Typical Characteristics (continued)

**$T_A$=25°C, $V_S$=5V, $V_{CM}$=$V_S$/2, unless otherwise noted**

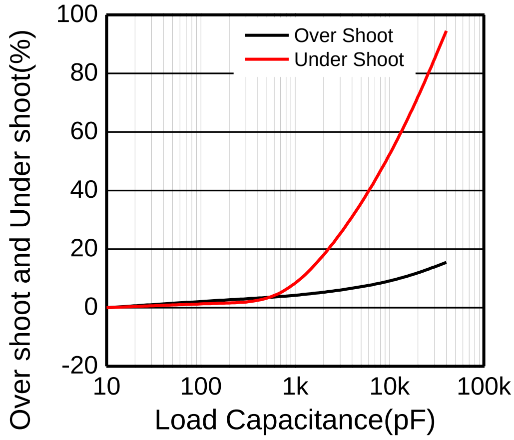
**Over-Shoot Voltage**

**Gain=-1,$C_{LOAD}$ = 40nF, $V_S$=±2.5V**



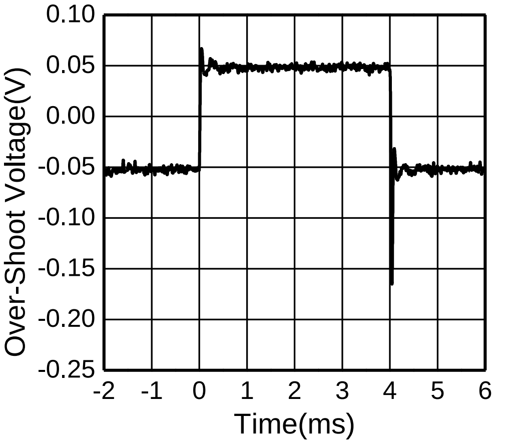

**Over-Shoot % vs. $C_{load}$**

**Gain=-1,$C_{LOAD}$ = 40nF, $V_S$=±2.5V**



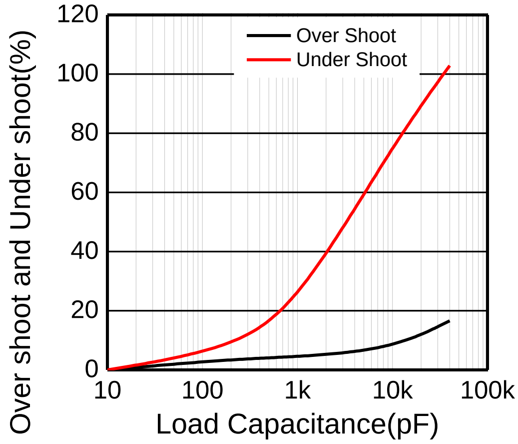

**Over-Shoot Voltage**

**Gain=+1,$C_{LOAD}$ = 40nF, $V_S$=±2.5V**

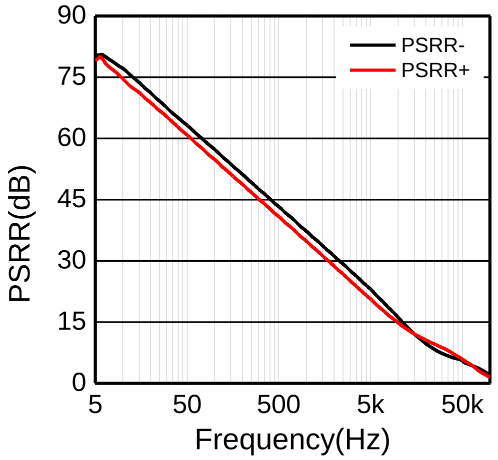



**Over-Shoot % vs. $C_{load}$**

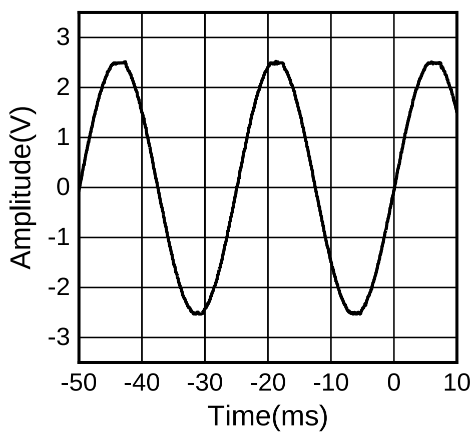
**Gain =+1, $C_{LOAD}$ = 40nF, $V_S$=±2.5V**




**Power-Supply Rejection Ratio**



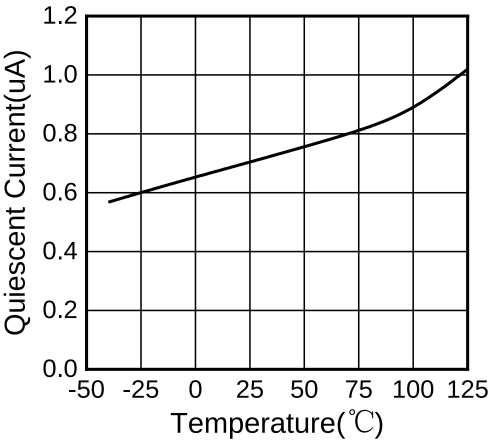

**VIN = -0.2V to 5.7V, No Phase Reversal**



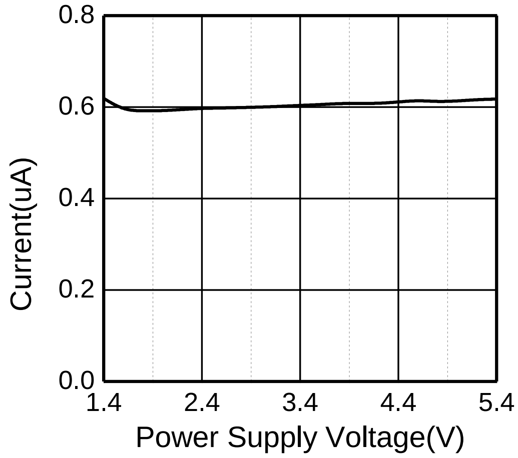
## Typical Characteristics (continued)

**$T_A$=25°C, $V_S$=5V, $V_{CM}$=$V_S$/2, unless otherwise noted**

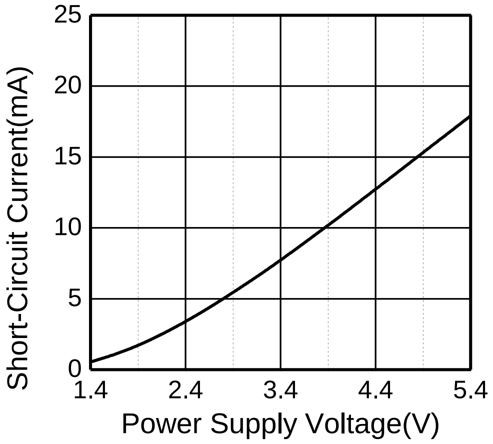
**Quiescent Supply Current vs. Temperature**



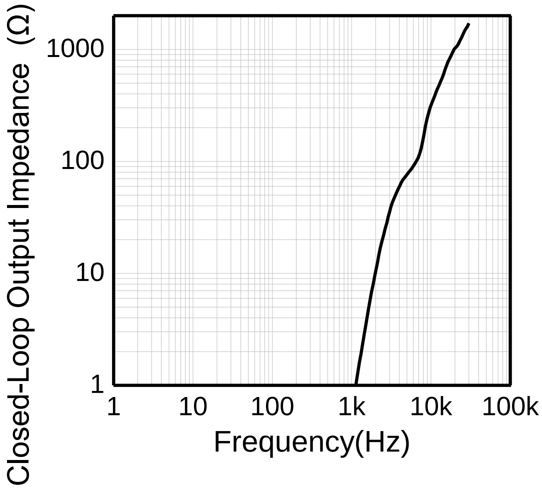

**Quiescent Supply Current vs. Supply Voltage**



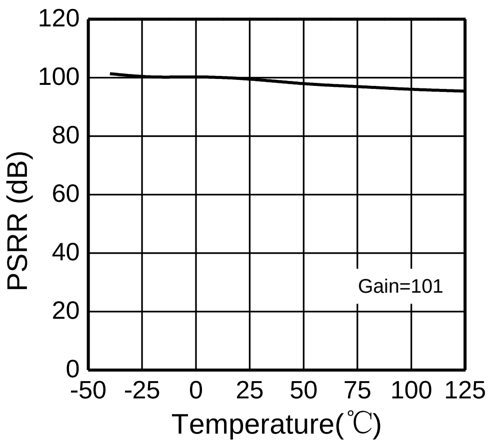

**Short-Circuit Current vs. Supply Voltage**



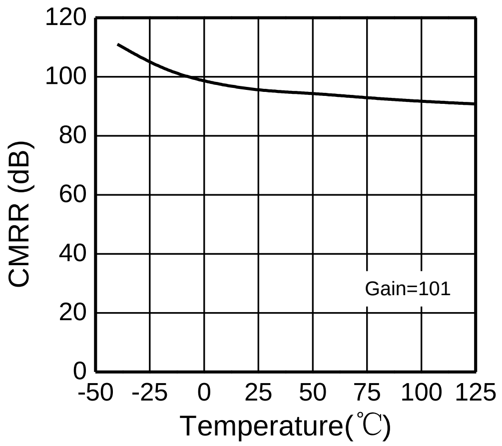

**Closed-Loop Output Impedance vs. Frequency**




**PSRR vs. Frequency**



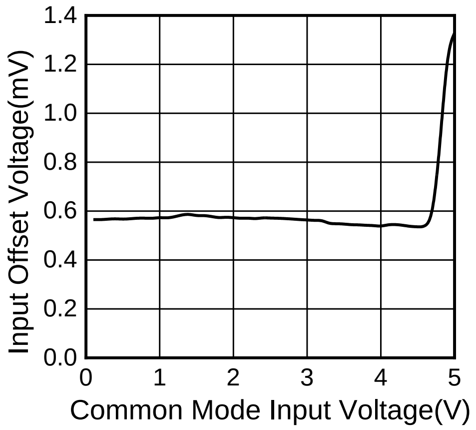

**CMRR vs. Temperature**



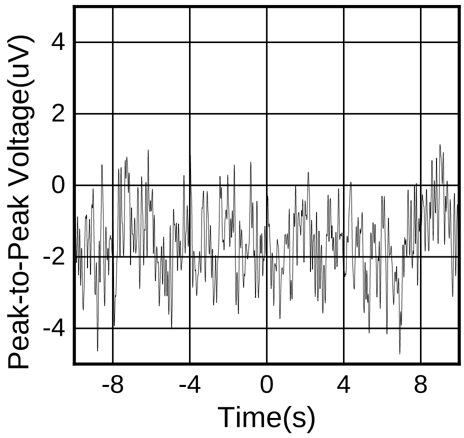
## Typical Characteristics (continued)

**$T_A$=25°C, $V_S$=5V, $V_{CM}$=$V_S$/2, unless otherwise noted**

**Input Offset Voltage vs. Common Mode Input Voltage**

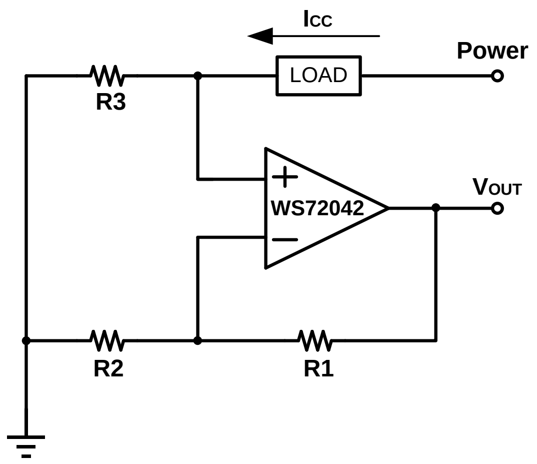



**0.1Hz to 10Hz Time Domain Output Voltage Noise**



## Application Circuit

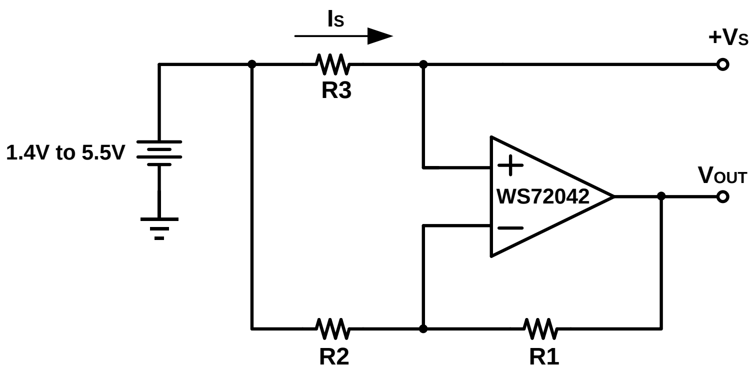
### (1) WS72042 in Low Side Battery Current Sensor




**Application Circuit for Low Side Battery Current Sensor**

$$V_{OUT} = I_{CC} \times R_3 \times (\frac{R_1}{R_2} + 1)$$

### (2) WS72042 in High Side Battery Current Sensor

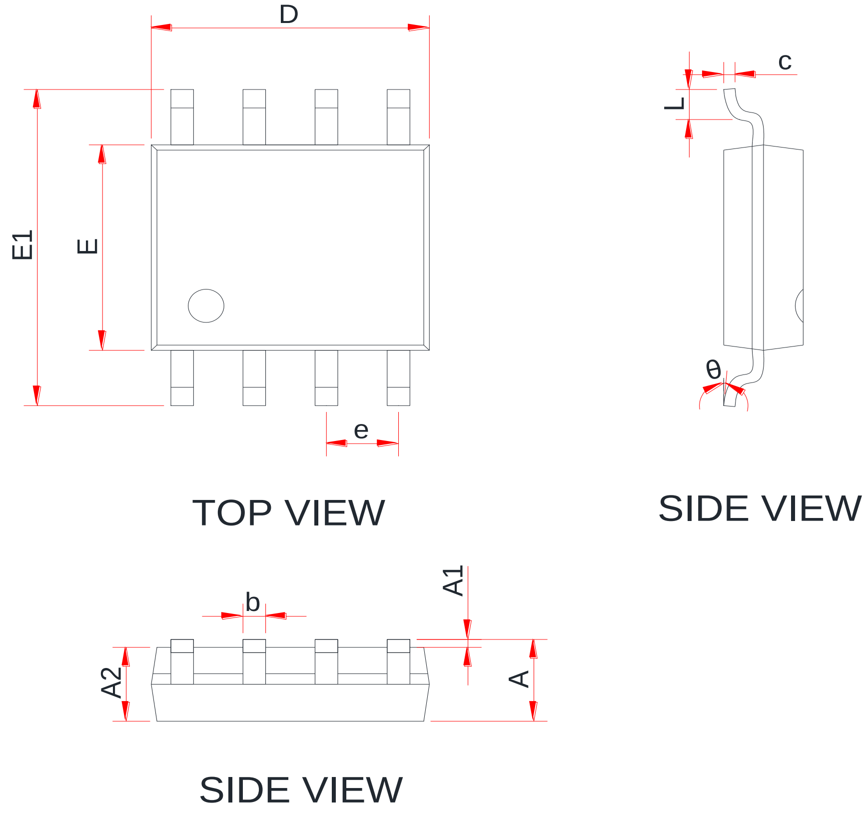



**Application Circuit for High Side Battery Current Sensor**

$$I_S = \frac{+V_S - V_{OUT}}{R_1 \times R_3 \div R_2}$$

## PACKAGE OUTLINE DIMENSIONS

**SOP-8L**

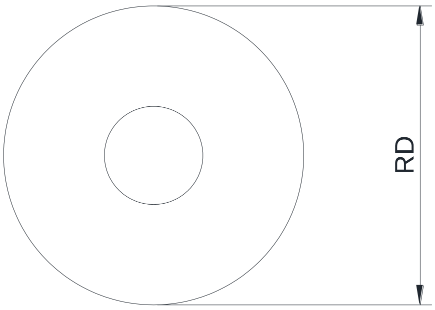



| Symbol | Dimensions In Millimeters (mm) | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 1.35 | 1.55 | 1.75 |
| A1 | 0.05 | 0.15 | 0.25 |
| A2 | 1.25 | 1.40 | 1.65 |
| b | 0.33 | - | 0.51 |
| c | 0.15 | - | 0.26 |
| D | 4.70 | 4.90 | 5.10 |
| E | 3.70 | 3.90 | 4.10 |
| E1 | 5.80 | 6.00 | 6.20 |
| e | 1.27BSC | | |
| L | 0.40 | - | 1.27 |
| θ | 0° | - | 8° |

## TAPE AND REEL INFORMATION

### SOP-8L

### Reel Dimensions

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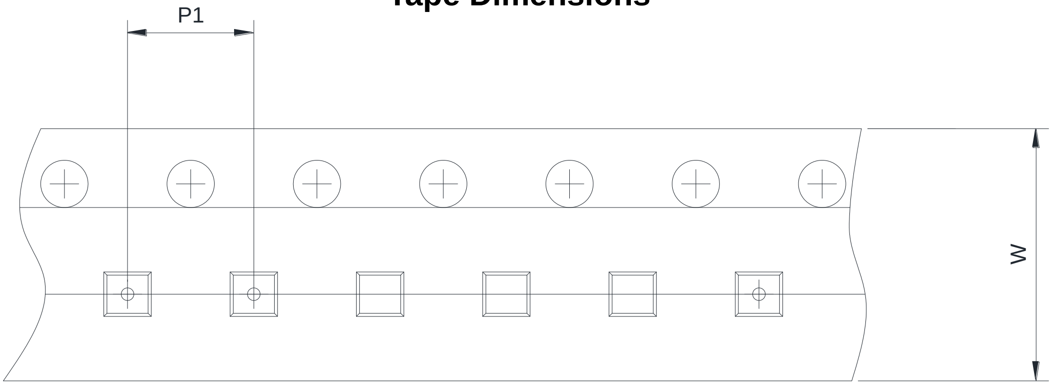
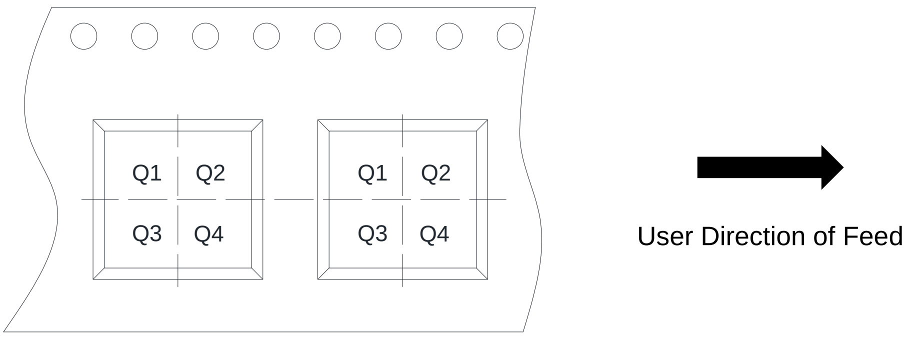


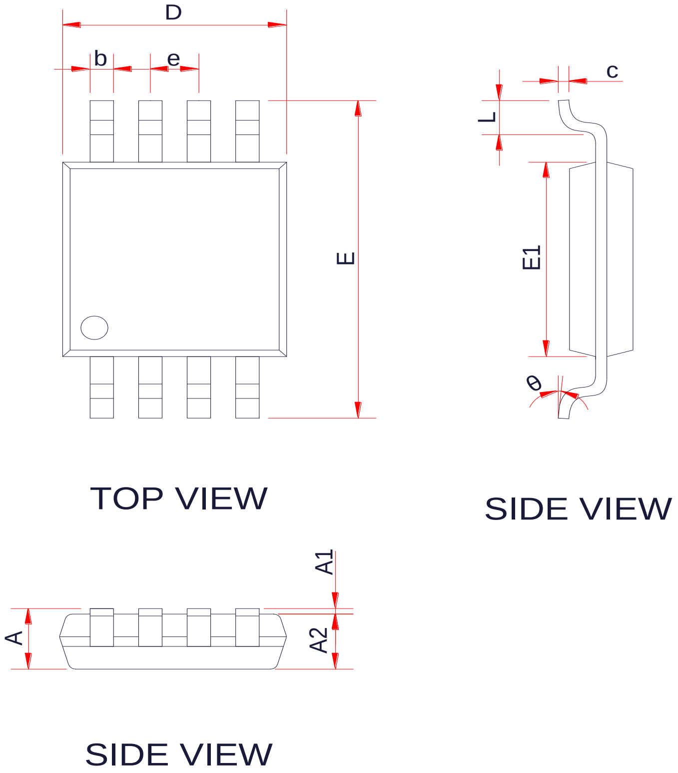

### Quadrant Assignments For PIN1 Orientation In Tape




| | | |
|---|---|---|
| RD | Reel Dimension | ☐ 7inch ☑ 13inch |
| W | Overall width of the carrier tape | ☐ 8mm ☑ 12mm |
| P1 | Pitch between successive cavity centers | ☐ 2mm ☐ 4mm ☑ 8mm |
| Pin1 | Pin1 Quadrant | ☑ Q1 ☐ Q2 ☐ Q3 ☐ Q4 |

## PACKAGE OUTLINE DIMENSIONS

### MSOP-8L

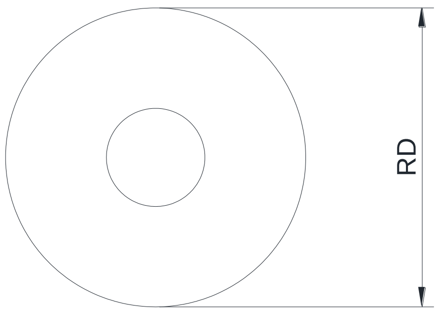



| Symbol | Dimensions In Millimeters (mm) | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | - | - | 1.10 |
| A1 | 0.02 | - | 0.15 |
| A2 | 0.75 | 0.80 | 0.95 |
| b | 0.25 | - | 0.38 |
| c | 0.09 | - | 0.23 |
| D | 2.90 | 3.00 | 3.10 |
| E | 4.75 | 4.90 | 5.05 |
| E1 | 2.90 | 3.00 | 3.10 |
| e | 0.65 BSC | | |
| L | 0.40 | - | 0.80 |
| θ | 0° | - | 6° |

## TAPE AND REEL INFORMATION

### MSOP-8L

### Reel Dimensions

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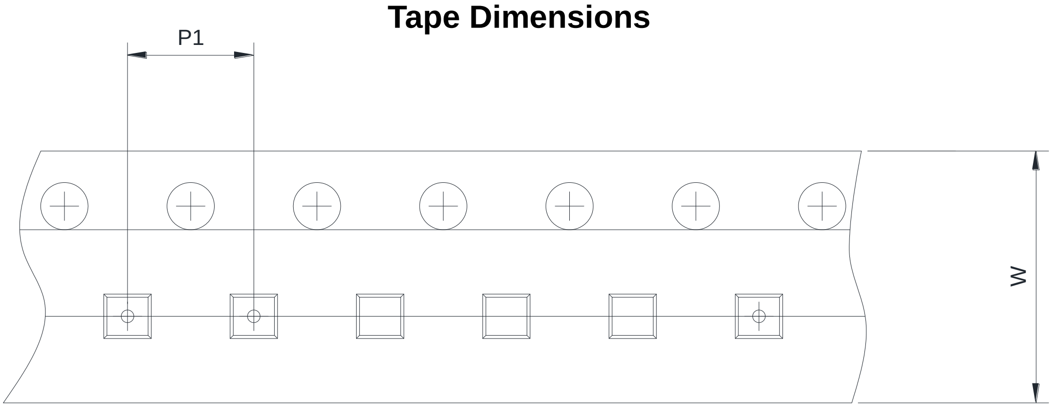


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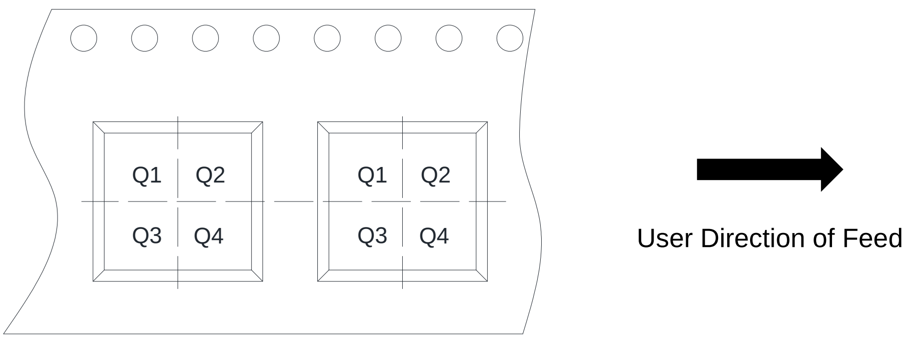


| | | | | | |
|---|---|---|---|---|---|
| RD | Reel Dimension | ☐ 7inch | ☑ 13inch | | |
| W | Overall width of the carrier tape | ☐ 8mm | ☑ 12mm | | |
| P1 | Pitch between successive cavity centers | ☐ 2mm | ☐ 4mm | ☑ 8mm | |
| Pin1 | Pin1 Quadrant | ☑ Q1 | ☐ Q2 | ☐ Q3 | ☐ Q4 |