

WS72141
300nA Nano-Power Rail-to-Rail Input Output Operational Amplifiers
[Http://www.willsemi.com](http://www.willsemi.com)
Descriptions

The WS72141 is a single 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 WS72141 has a gain-bandwidth product of 13kHz (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.

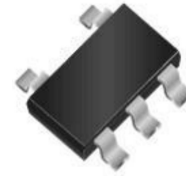
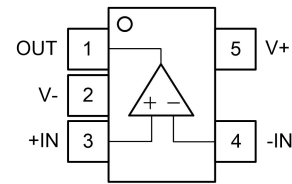
WS72141 is available in SOT-23-5L packages. Standard products are Pb-Free and halogen-Free.

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

Features

- Wide Supply Voltage : 1.6~5.5V
- Quiescent Current per Amplifier : 300nA Typical
- GBWP : 13kHz
- Rail-to-Rail Input/Output Swing
- Unity Gain Stable
- -40°C to 125°C Operation Temperature Range
- Available in Green SOT-23-5L Packages


SOT-23-5L

SOT-23-5L
Pin configuration (Top view)

SOT-23-5L
Marking

- 2141** = Device code
GE = Special code
Y = Year code
W = Week code

Order Information

Device	Package	Shipping
WS72141E-5/TR	SOT-23-5L	3000/Reel & Tape

Pin Descriptions

Pin Number	Symbol	Descriptions
1	OUT	Output
2	V-	Negative supply
3	+IN	Non-inverting input
4	-IN	Inverting input
5	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 Free-Air Temperature Range	T_A	-40 to 125	°C
Storage Temperature Range	T_{STG}	-65 to 150	°C
Junction Temperature Range	T_J	150	°C
Lead Temperature Range	T_L	260	°C

Note:

- 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.
- All voltage values, except differential voltage are with respect to network terminal.
- A heat sink may be required to keep the junction temperature below the absolute maximum, 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 leads.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum level	Unit
HBM	Human Body Model ESD	MIL-STD-883H Method 3015.8 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

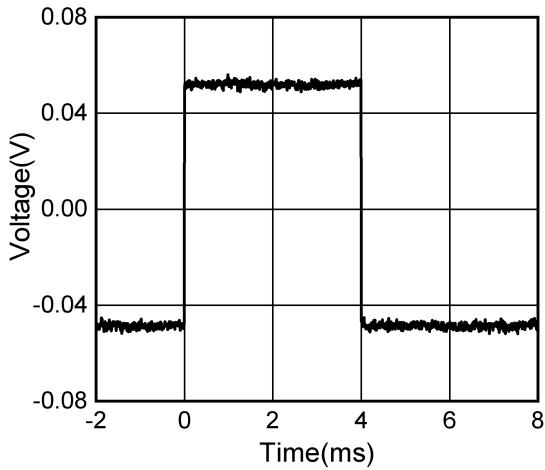
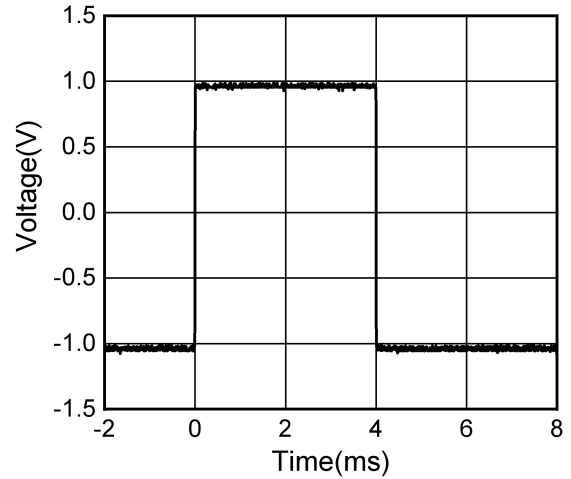
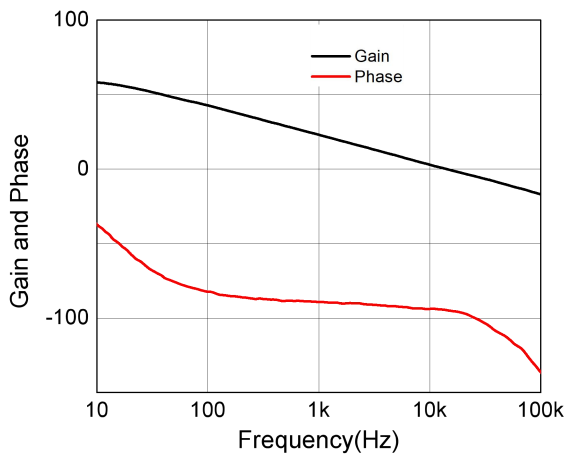
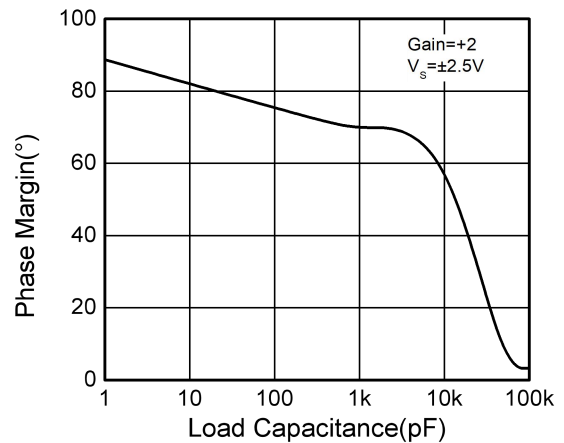
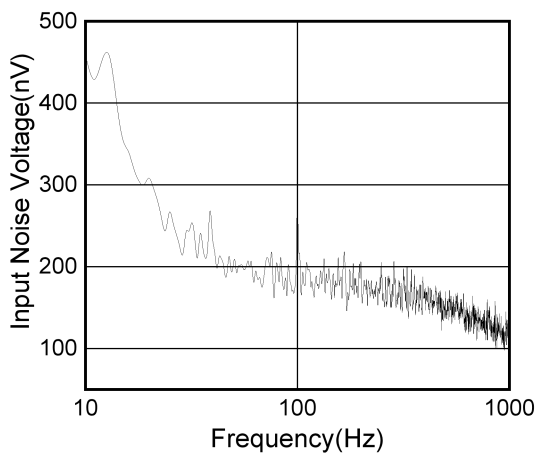
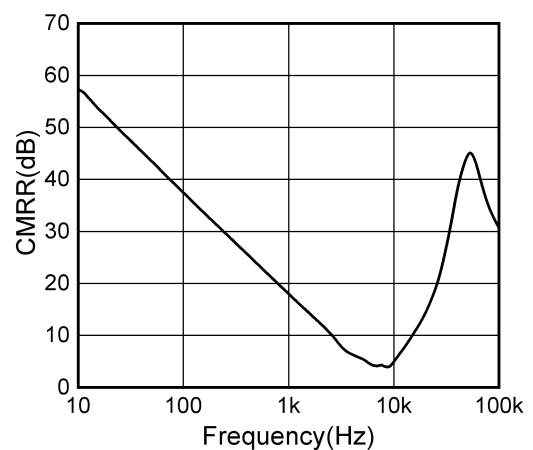
The *denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 27^\circ\text{C}$. $V_S = 5\text{V}$, $V_{\text{CM}} = V_{\text{OUT}} = V_S/2$, $R_{\text{load}} = 100\text{k}\Omega$, $C_{\text{load}} = 60\text{pF}$.

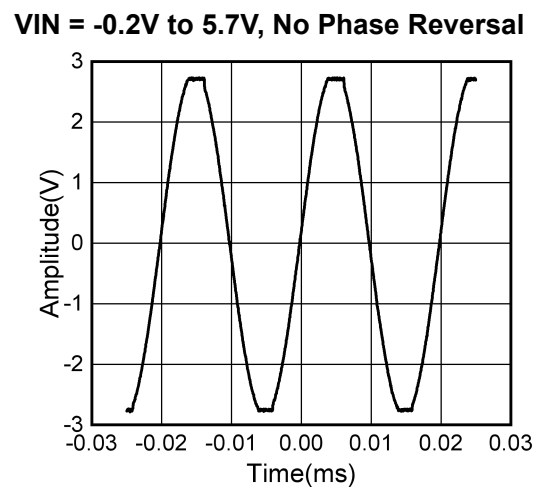
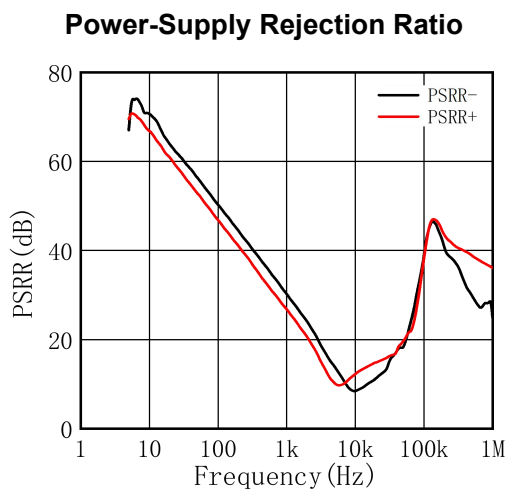
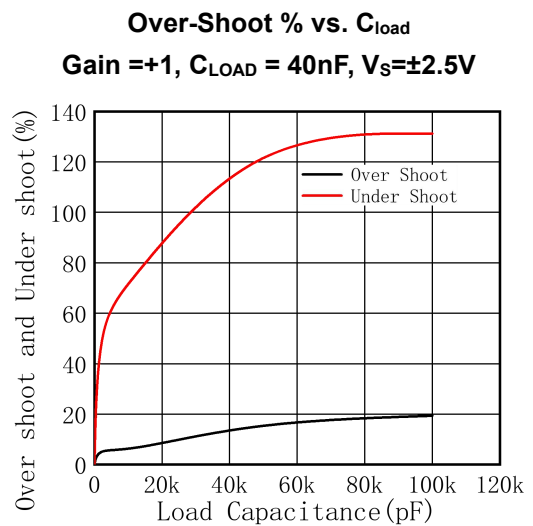
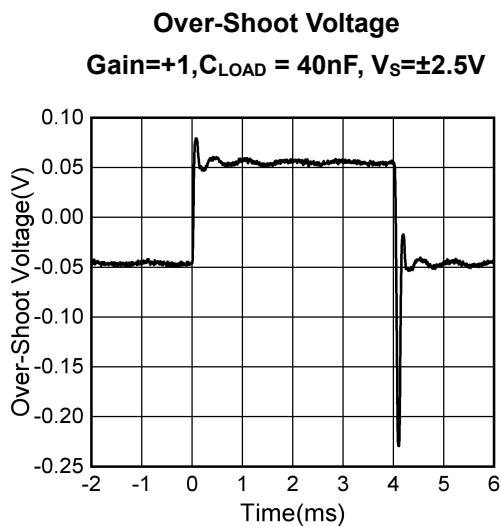
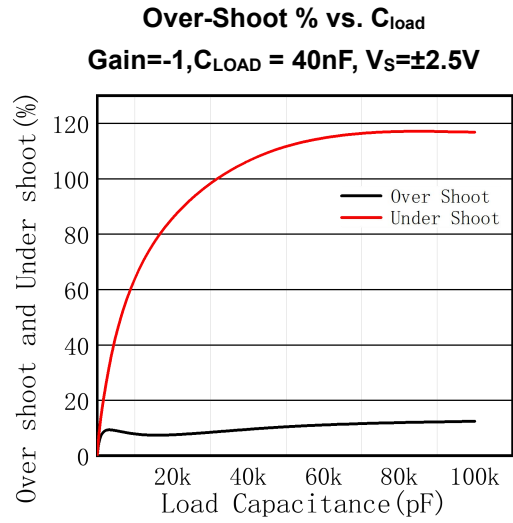
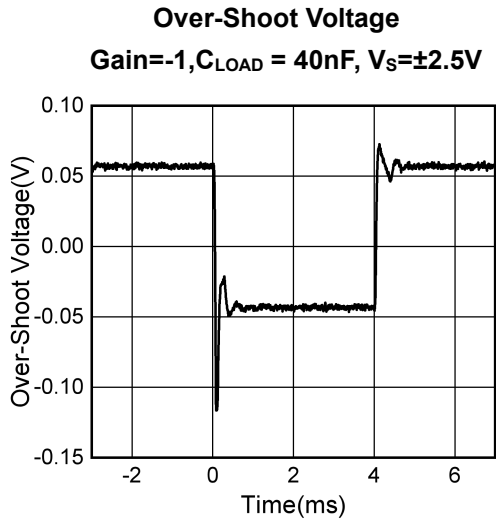
Symbol	Parameter		Conditions	Min.	Typ.	Max.	Unit
V_{OS}	Input Offset Voltage		$V_{\text{CM}} = V_S/2$ and $V_{\text{CM}} = \text{GND}$ *	-3.5	± 0.1	3.5	mV
α_{VOS}	Input Offset Voltage Drift				1.6		$\mu\text{V}/^\circ\text{C}$
I_{IB}	Input Bias Current				<10		pA
I_{OS}	Input Offset Current				<10		pA
V_n	Input Voltage Noise		$f = 0.1\text{Hz to } 10\text{Hz}$		8		$\mu\text{V}_{\text{P-P}}$
e_n	Input Voltage Noise Density		$f = 1\text{kHz}$		80		$\text{nV}/\sqrt{\text{Hz}}$
R_{IN}	Input Resistance				>1		T Ω
CMRR	Common Mode Rejection Ratio		$V_{\text{CM}} = 0.1\text{V to } 4.9\text{V}$ *	55	75		dB
V_{CM}	Common Mode Input Voltage Range			$(V^-) - 0.3$		$(V^+) + 0.3$	V
PSRR	Power Supply Rejection Ratio			65	91		dB
A_{VOL}	Open Loop Large Signal Gain		$V_{\text{OUT}} = 2.5\text{V}, R_{\text{load}} = 100\text{k}\Omega$		118		dB
			$V_{\text{OUT}} = 0.1\text{V to } 4.9\text{V}, R_{\text{load}} = 100\text{k}\Omega$ *	85	118		dB
$V_{\text{OL}}, V_{\text{OH}}$	Output Swing from Supply Rail		$R_{\text{load}} = 100\text{k}\Omega$		5		mV
R_{OUT}	Closed-Loop Output Impedance		$G = 1, f = 1\text{kHz}, I_{\text{OUT}} = 0$		4.3		Ω
I_{SC}	Output Short-Circuit Current		Sink or Source Current	12	15		mA
V_{DD}	Supply Voltage			1.6		5.5	V
I_{Q}	Quiescent Current per Amplifier				300	450	nA
PM	Phase Margin		$R_{\text{load}} = 100\text{k}\Omega, C_{\text{load}} = 60\text{pF}$		80		degrees
GM	Gain Margin		$R_{\text{load}} = 100\text{k}\Omega, C_{\text{load}} = 60\text{pF}$		18		dB
GBWP	Gain-Bandwidth Product		$f = 1\text{kHz}$		13		kHz
t_s	Settling Time	1.5 to 3.5V, Unity Gain	0.1%		0.4		ms
		2.45 to 2.55V, Unity Gain	0.1%		0.04		
SR	Slew Rate		$A_V = 1, V_{\text{OUT}} = 1.5\text{V to } 3.5\text{V}, R_{\text{load}} = 100\text{k}\Omega, C_{\text{load}} = 60\text{pF}$		7		$\text{mV}/\mu\text{s}$
FPBW	Full Power Bandwidth ^{Note1}		$2V_{\text{P-P}}$		300		Hz

Note:

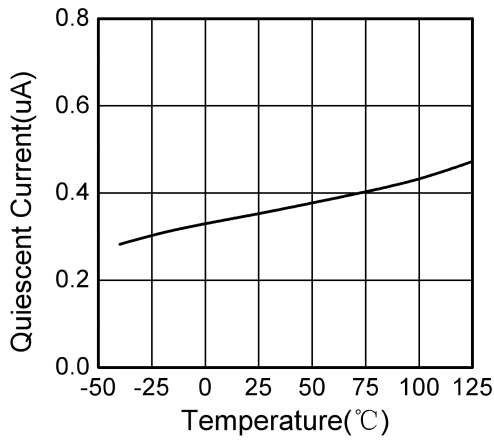
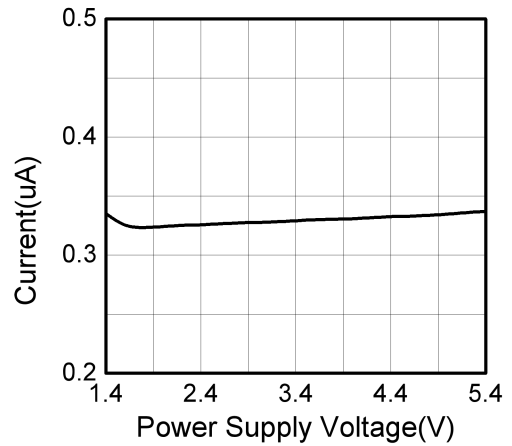
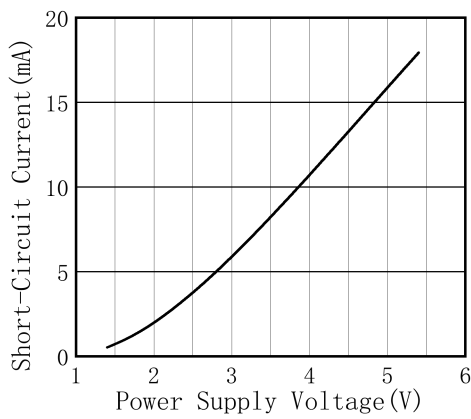
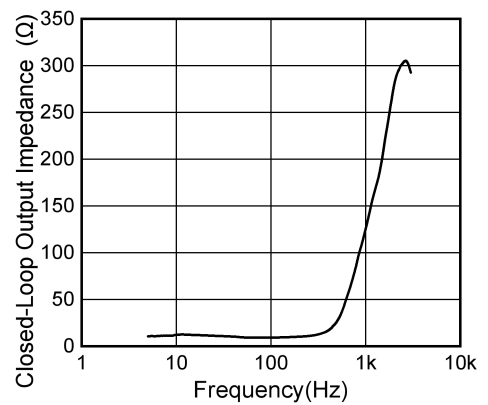
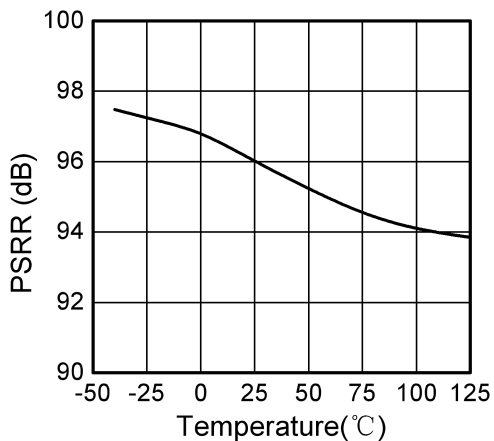
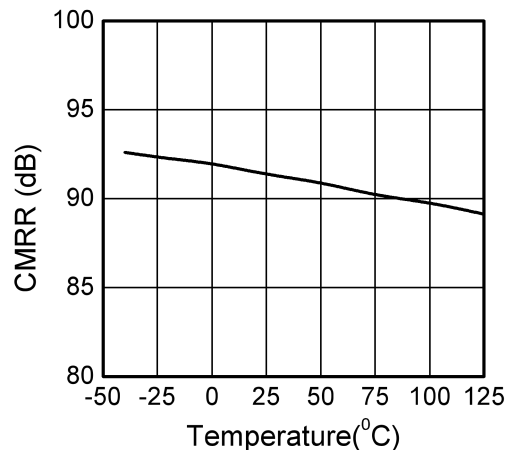
1. Full power bandwidth is calculated from the slew rate $\text{FPBW} = \text{SR}/(\pi \cdot V_{\text{P-P}})$.

Typical Characteristics
 $T_A=25^\circ\text{C}$, $V_S=5\text{V}$, $V_{CM}=V_S/2$, unless otherwise noted

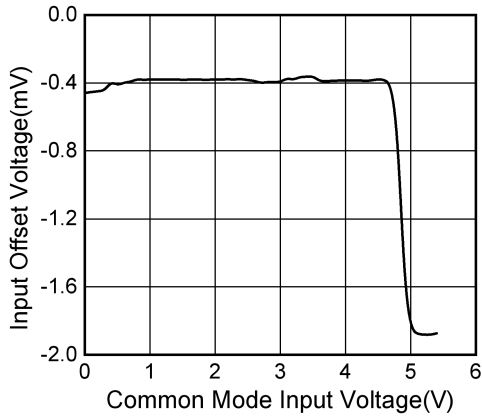
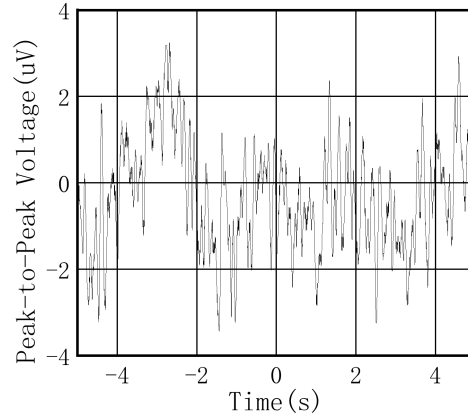
Small-Signal Step Response, 100mV Step

Large-Signal 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


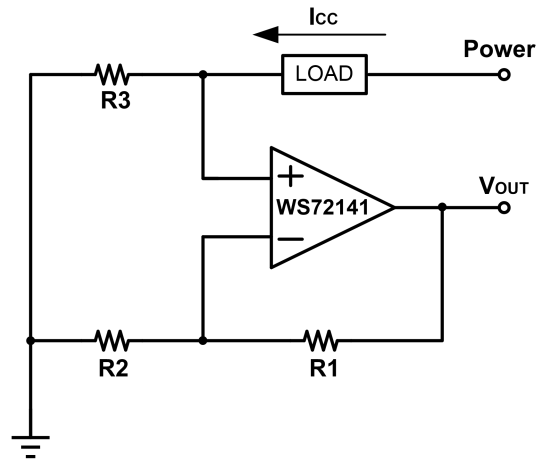
Typical Characteristics (continued)
 $T_A=25^{\circ}\text{C}$, $V_S=5\text{V}$, $V_{\text{CM}}=V_S/2$, unless otherwise noted


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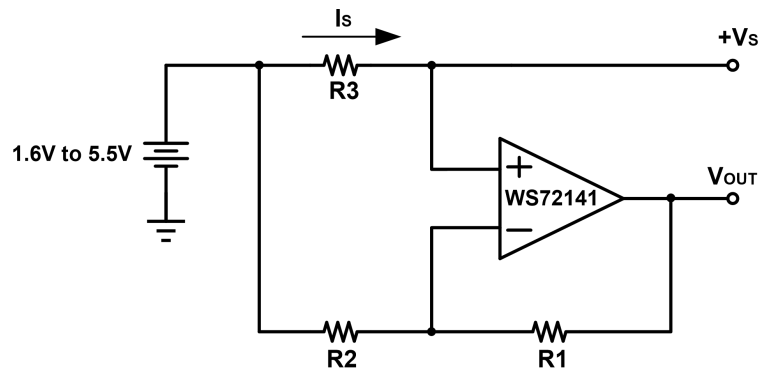
Quiescent Supply Current vs. Temperature

Quiescent Supply Current vs. Supply Voltage

Short-Circuit Current vs. Supply Voltage

Closed-Loop Output Impedance vs. Frequency

PSRR vs. Temperature

CMRR vs. Temperature


Typical Characteristics (continued)
 $T_A=25^{\circ}\text{C}$, $V_S=5\text{V}$, $V_{\text{CM}}=V_S/2$, unless otherwise noted

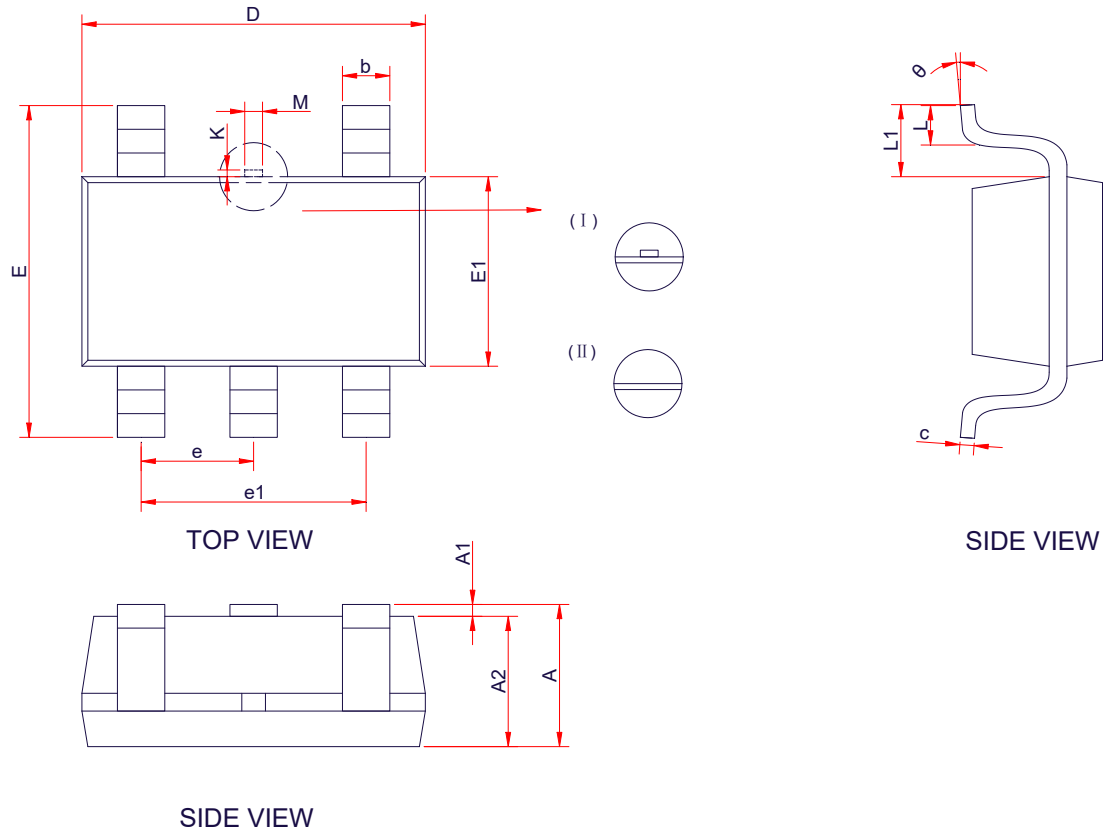
Input Offset Voltage vs. Common Mode Input Voltage

0.1Hz to 10Hz Time Domain Output Voltage Noise


Application Circuit
(1) WS72141 in Low Side Battery Current Sensor

Application Circuit for Low Side Battery Current Sensor

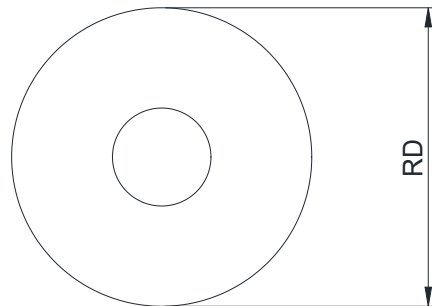
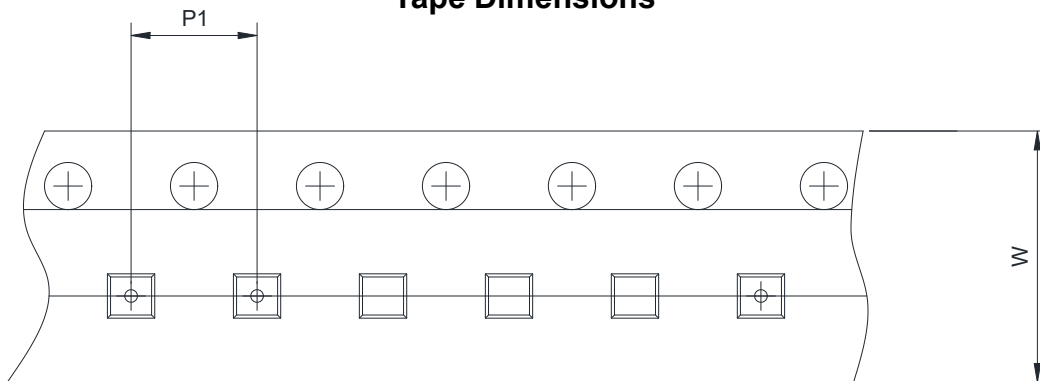
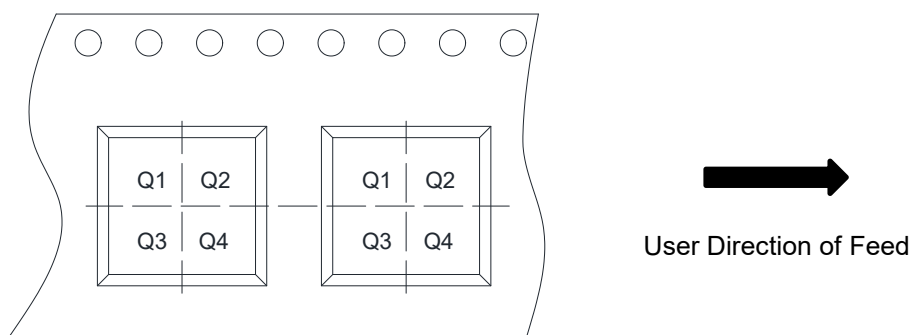
$$V_{OUT} = I_{CC} \times R_3 \times \left(\frac{R_1}{R_2} + 1 \right)$$

(2) WS72141 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
SOT-23-5L


Symbol	Dimensions in Millimeters		
	Min.	Typ.	Max.
A	-	-	1.45
A1	0.00	-	0.15
A2	0.90	1.10	1.30
b	0.30	0.40	0.50
c	0.10	-	0.21
D	2.72	2.92	3.12
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	0.95 BSC		
e1	1.90 BSC		
L	0.30	0.45	0.60
M	0.10	0.15	0.25
K	0.00	-	0.25
θ	0°	-	8°

TAPE AND REEL INFORMATION
Reel Dimensions

Tape Dimensions

Quadrant Assignments For PIN1 Orientation In Tape


RD	Reel Dimension	<input checked="" type="checkbox"/> 7inch	<input type="checkbox"/> 13inch
W	Overall width of the carrier tape	<input checked="" type="checkbox"/> 8mm	<input type="checkbox"/> 12mm <input type="checkbox"/> 16mm
P1	Pitch between successive cavity centers	<input type="checkbox"/> 2mm	<input checked="" type="checkbox"/> 4mm <input type="checkbox"/> 8mm
Pin1	Pin1 Quadrant	<input type="checkbox"/> Q1	<input type="checkbox"/> Q2 <input checked="" type="checkbox"/> Q3 <input type="checkbox"/> Q4

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