

MAXIM

Precision, High-Side Current-Sense Amplifiers

MAX471/MAX472

General Description

The MAX471/MAX472 are complete, bidirectional, high-side current-sense amplifiers for portable PCs, telephones, and other systems where battery/DC power-line monitoring is critical. High-side power-line monitoring is especially useful in battery-powered systems, since it does not interfere with the ground paths of the battery chargers or monitors often found in "smart" batteries.

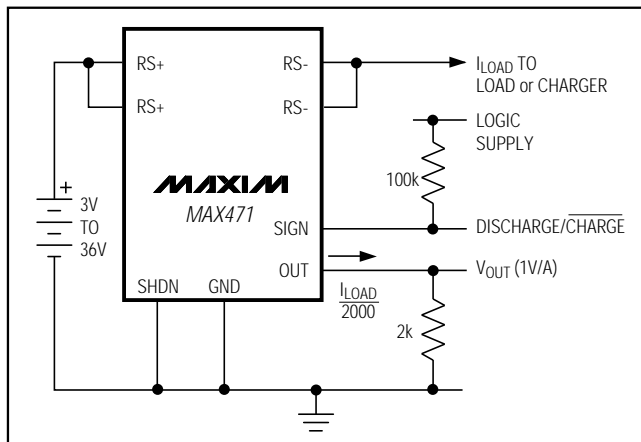
The MAX471 has an internal 35mΩ current-sense resistor and measures battery currents up to ±3A. For applications requiring higher current or increased flexibility, the MAX472 functions with external sense and gain-setting resistors. Both devices have a current output that can be converted to a ground-referred voltage with a single resistor, allowing a wide range of battery voltages and currents.

An open-collector SIGN output indicates current-flow direction, so the user can monitor whether a battery is being charged or discharged. Both devices operate from 3V to 36V, draw less than 100μA over temperature, and include a 18μA max shutdown mode.

Applications

- Portable PCs:
 - Notebooks/Subnotebooks/Palmtops
- Smart Battery Packs
- Cellular Phones
- Portable Phones
- Portable Test/Measurement Systems
- Battery-Operated Systems
- Energy Management Systems

Typical Operating Circuit



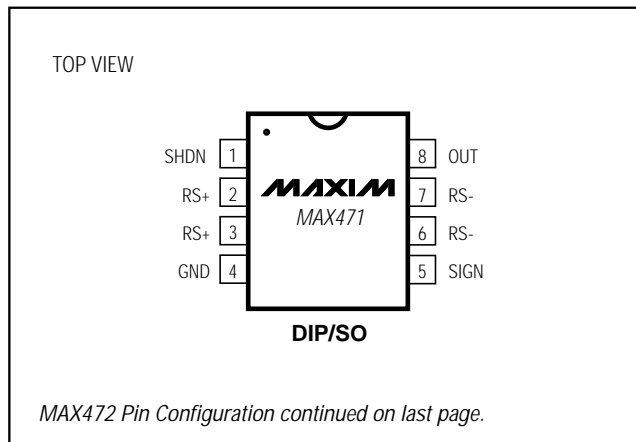
Features

- ◆ Complete High-Side Current Sensing
- ◆ Precision Internal Sense Resistor (MAX471)
- ◆ 2% Accuracy Over Temperature
- ◆ Monitors Both Charge and Discharge
- ◆ 3A Sense Capability with Internal Sense Resistor (MAX471)
- ◆ Higher Current-Sense Capability with External Sense Resistor (MAX472)
- ◆ 100μA Max Supply Current
- ◆ 18μA Max Shutdown Mode
- ◆ 3V to 36V Supply Operation
- ◆ 8-Pin DIP/SO Packages

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX471CPA	0°C to +70°C	8 Plastic DIP
MAX471CSA	0°C to +70°C	8 SO
MAX471EPA	-40°C to +85°C	8 Plastic DIP
MAX471ESA	-40°C to +85°C	8 SO
MAX472CPA	0°C to +70°C	8 Plastic DIP
MAX472CSA	0°C to +70°C	8 SO
MAX472EPA	-40°C to +85°C	8 Plastic DIP
MAX472ESA	-40°C to +85°C	8 SO

Pin Configurations



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ABSOLUTE MAXIMUM RATINGS

Supply Voltage, RS+, RS-, VCC to GND.....-0.3V, +40V
 RMS Current, RS+ to RS- (MAX471 only).....±3.3A
 Peak Current, (RS+ to RS-)see Figure 5
 Differential Input Voltage, RG1 to RG2 (MAX472 only)±0.3V
 Voltage at Any Pin Except SIGN
 MAX471 only-0.3V to (RS+ - 0.3V)
 MAX472 only-0.3V to (VCC + 0.3V)
 Voltage at SIGN.....-0.3V to +40V
 Current into SHDN, GND, OUT, RG1, RG2, VCC.....±50mA
 Current into SIGN.....+10mA, -50mA

Continuous Power Dissipation (TA = +70°C)

MAX471 (Note 1):
 Plastic DIP (derate 17.5mW/°C above +70°C)1.4W
 SO (derate 9.9mW/°C above +70°C).....791mW
 MAX472 :
 Plastic DIP (derate 9.09mW/°C above +70°C)727mW
 SO (derate 5.88mW/°C above +70°C).....471mW
 Operating Temperature Ranges
 MAX47_C_A.....0°C to +70°C
 MAX47_E_A.....-40°C to +85°C
 Junction Temperature Range.....-60°C to +150°C
 Storage Temperature Range.....-60°C to +160°C
 Lead Temperature (soldering, 10sec).....+300°C

Note 1: Due to special packaging considerations, MAX471 (DIP, SO) has a higher power dissipation rating than the MAX472. RS+ and RS- must be soldered to large copper traces to achieve this dissipation rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—MAX471

(RS+ = +3V to +36V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Supply Voltage	VRS+		3		36	V	
Supply Current	IRS+	ILOAD = 0A, excludes ISIGN		50	113	µA	
Sense Current	ILOAD				±3	ARMS	
Sense Resistor	RSENSE			35	70	mΩ	
Current-Sense Ratio	IOUT/ ILOAD	ILOAD = 1A, RS+ = 10V	MAX471C	0.490	0.500	0.510	mA/A
			MAX471E	0.4875	0.500	0.5125	
No-Load OUT Error		ILOAD = 0A, RS+ = 10V	MAX471C			2.5	µA
			MAX471E			3.0	
Low-Level OUT Error		ILOAD = 30mA, RS+ = 10V	MAX471C			±2.5	µA
			MAX471E			±3.0	
Power-Supply Rejection Ratio	PSRR	3V ≤ RS+ ≤ 36V, ILOAD = 1A			0.1	%/V	
SIGN Threshold (ILOAD required to switch SIGN)		MAX471C		±4.0	±6.0	mA	
		MAX471E			±7.0		
SIGN Output Leakage Current		VSIGN = 36V			1.0	µA	
SIGN Sink Current	IOL	VSIGN = 0.3V	0.1			mA	
Shutdown Supply Current	IRS+(SHDN)	VSHDN = 2.4V; VCC = 3V to 20V		1.5	18.0	µA	
SHDN Input Low Voltage	VIL				0.3	V	
SHDN Input Low Current	IIL	VSHDN = 0V			1.0	µA	
SHDN Input High Voltage	VIH		2.4			V	
SHDN Input High Current	IIH	VSHDN = 2.4V			1.0	µA	
OUT Output Voltage Range	VOUT		0	VRS+ - 1.5		V	
OUT Output Resistance	ROUT	ILOAD = 3.0A, VOUT = 0V to (VRS+ - 1.5V)	1	3		MΩ	
OUT Rise, Fall Time	tR, tF	ILOAD = 50mA to 3.0A, ROUT = 2kΩ, COUT = 50pF, 10% to 90%		4		µs	
OUT Settling Time to 1% of Final Value	ts	ILOAD = 100mA to 3.0A, ROUT = 2kΩ, COUT = 50pF		15		µs	

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ELECTRICAL CHARACTERISTICS—MAX472

($V_{CC} = +3V$ to $+36V$, $R_{G1} = R_{G2} = 200\Omega$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}			3		36	V
Supply Current	I_{CC}	$I_{LOAD} = 0A$, excludes I_{SIGN} ; $V_{CC} = 3V$ to $20V$			20	48	μA
Input Offset Voltage (Note 2)	V_{OS}	MAX472C				120	μV
		MAX472E				140	
Input Bias Current	I_{RG1}, I_{RG2}				20	35	μA
Input Bias-Current Matching	I_{OS}	$I_{RG1} - I_{RG2}$			± 0.4	± 3.0	μA
OUT Current Accuracy	I_{RG}/I_{OUT}	$V_{SENSE} = 100mV$, $V_{CC} = 10V$ (Note 3)	MAX472C			± 2	%
			MAX472E			± 2.5	
No-Load OUT Error		$V_{CC} = 10V$, $V_{SENSE} = 0V$	MAX472C			2.5	μA
			MAX472E			3	
Low-Level OUT Error		$V_{CC} = 10V$, $V_{SENSE} = 3mV$	MAX472C			± 2.5	μA
			MAX472E			± 3.0	
Power-Supply Rejection Ratio	PSRR	$3V \leq V_{CC} \leq 36V$, $V_{SENSE} = 100mV$				0.1	%/V
SIGN Threshold (V_{SENSE} required to switch SIGN)		$V_{CC} = 10V$	MAX472C		60	120	μV
			MAX472E		60	140	
SIGN Output Leakage Current		$V_{SIGN} = 36V$				1.0	μA
SIGN Output Sink Current		$V_{SIGN} = 0.3V$		0.1			mA
Shutdown Supply Current	$I_{CC}(SHDN)$	$V_{SHDN} = 2.4V$; $V_{CC} = 3V$ to $20V$			1.5	18.0	μA
SHDN Input Low Voltage	V_{IL}					0.3	V
SHDN Input Low Current	I_{IL}	$V_{SHDN} = 0V$				1.0	μA
SHDN Input High Voltage	V_{IH}			2.4			V
SHDN Input High Current	I_{IH}	$V_{SHDN} = 2.4V$				1.0	μA
OUT Output Voltage Range	V_{OUT}			0		$V_{CC} - 1.5$	V
OUT Output Resistance	R_{OUT}	$I_{OUT} = 1.5mA$		1	3		$M\Omega$
OUT Rise, Fall Time	t_R, t_F	$V_{SENSE} = 5mV$ to $150mV$, $R_{OUT} = 2k\Omega$, $C_{OUT} = 50pF$, 10% to 90%			4		μs
OUT Settling Time to 1% of Final Value	t_s	$V_{SENSE} = 5mV$ to $150mV$, $R_{OUT} = 2k\Omega$, $C_{OUT} = 50pF$			15		μs
Maximum Output Current	I_{OUT}			1.5			mA

Note 2: V_{OS} is defined as the input voltage (V_{SENSE}) required to give minimum I_{OUT} .

Note 3: V_{SENSE} is the voltage across the sense resistor.