Zero Drift, Bi-Directional Current Shunt Monitor

Preliminary Technical Data

AD8217

FEATURES

- **High common-mode voltage range**
  - **4.5 V to +80 V operating**
  - **0 V to +85 V survival**
- **Buffered output voltage**
- **Gain = 20V/V**
- **Unidirectional or Bidirectional Operation**
- **Wide operating temperature range**
  - **8-Lead MSOP_N: –40°C to +125°C**
- **Excellent ac and dc performance**
  - **100 nV/°C typical offset drift**
  - **100uV typical offset voltage**
  - **10 ppm/°C typical gain drift**
  - **100 dB typical CMRR at dc**

APPLICATIONS

- **High-side current sensing**
- **48V telecom**
- **Power Management**
- **Base Stations**

FUNCTIONAL BLOCK DIAGRAM

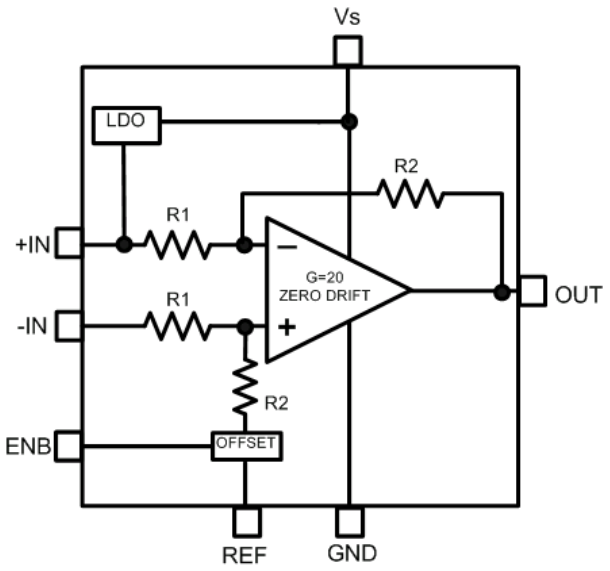

Figure 1.

GENERAL DESCRIPTION

The AD8217 is a high voltage, zero drift, high-resolution bi-directional current shunt amplifier. It features a set gain of 20V/V, with a maximum ±0.3% gain error over the entire temperature range. The buffered output voltage directly interfaces with any typical converter. Excellent common-mode rejection is available throughout the 4.5V to +80V common mode input range. The AD8217 performs unidirectional or bidirectional current measurements across a shunt resistor in a variety of applications, such as motor control, telecom, and power management. Using an internal LDO, the AD8217 can operate with a 4.5V to 80V supply when Vs=NC (no connect), or Vs can be connected to a separate 5V supply. The user can enable an internal 80mV reference, which offsets the output allowing for accurate zero load current measurements. Additionally, an external low impedance reference can be used to offset the output from 0V to 5V, allowing for bidirectional current sensing. This enhanced functionality, coupled with the zero drift operation of the AD8217, makes for a extremely precise, high resolution, current sense solution. The AD8217 features an operating temperature range of –40°C to +125°C and is offered in a small 8L-MSOP package.

Rev. 0

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REVISION HISTORY

2/10—Revision 0: Initial Version

SPECIFICATIONS

T_{OPR} = −40°C to +125°C, T_A = 25°C, Vcm = 4.5 to 80V, R_L = 25 kΩ (R_L is the output load resistor), unless otherwise noted.

Table 1.

Parameter	Min	Typ	Max	Unit	Conditions
GAIN					
Initial		20		V/V	
Accuracy			±0.15	%	
Accuracy Over Temperature			±0.3	%	T_{OPR}
Drift	-10		10	ppm/°C	T_{OPR}
VOLTAGE OFFSET					
Offset Voltage, RTI			±100	uV	T_A
Over Temperature, RTI			±200	uV	Vs= NC or 5V, T_{OPR}
Drift			±100	nV/°C	Vs= NC or 5V, T_{OPR}
INPUT					
Bias Current		1		mA	Vs= NC
		0.5		mA	Vs=5V
Common-Mode Input Voltage Range	4.5		+80	V	Vs=NC and Vs=5V
Differential Input Voltage Range		250		mV	Differential input voltage
Common-Mode Rejection Ratio	90	110		dB	Vs=NC or 5V, T_{OPR}
OUTPUT					
Output Voltage Range Low	0.02			V	Sinking 100uA, Vs=NC or5V, T_{OPR}
Output Voltage Range High			Vcm-0.1	V	Sourcing 100uA, Vs=NC or 5V, T_{OPR}
Output Impedance		1		Ω	
INTERNAL REFERENCE (Pin 3 Connected to GND)					
Initial Value		80		mV	Output Voltage
Offset			±100	uV	
Offset Drift			±0.5	uV/C	Vs=NC or 5V
REFERENCE INPUT (Pin 7)					
Input Impedance		1.5		MΩ	
Input Current	3		60	uA	
Input Voltage Range	0		5	V	
Gain to Output		1± 0.0001		V/V	
DYNAMIC RESPONSE					
Small Signal −3 dB Bandwidth		350		kHz	T_{OPR}
Slew Rate		4		V/µs	T_A
NOISE					
0.1 Hz to 10 Hz, RTI		2.1		µV p-p	
Spectral Density, 1 kHz, RTI		110		nV/√Hz	
POWER SUPPLY					
Operating Range (Pin 2 Floating)	4.5		80	V	Vs=NC
Vs Range (Pin 2)	4.5		5.5	V	
Quiescent Current Over Temperature			1.5	mA	Throughout Vcm Range
Power Supply Rejection Ratio	90	110		dB	T_{OPR}
TEMPERATURE RANGE					
For Specified Performance	−40		+125	°C	

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage (Vs)	6 V
Continuous Input Voltage	0V to +85 V
Continuous Differential Input Voltage	5 V
Reverse Supply Voltage	−0.3 V
Human Body Model (HBM) ESD Rating	±2000 V
Operating Temperature Range	−40°C to +125°C
Storage Temperature Range	−65°C to +150°C
Output Short-Circuit Duration	Indefinite

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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 subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

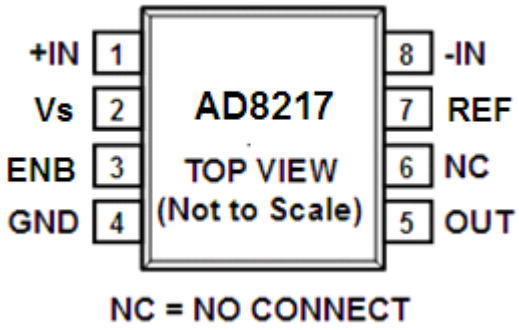


Figure 2. Pin Configuration

Table 3. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	+IN	Non Inverting Input and LDO input
2	Vs	Single 5V supply pin
3	ENB	Enable. Ground to active 80mV internal reference. Float for normal operation.
4	GND	Ground
5	OUT	Output
6	NC	
7	REF	External reference input.
8	-IN	Inverting Input.

THEORY OF OPERATION

In typical applications, the AD8217 amplifies a small differential input voltage generated by the load current flowing through a shunt resistor. The AD8217 rejects high common-mode voltages (up to 80V) and provides a ground-referenced, buffered output that interfaces with an analog-to-digital converter (ADC). Figure 3 shows a simplified schematic of the AD8217.

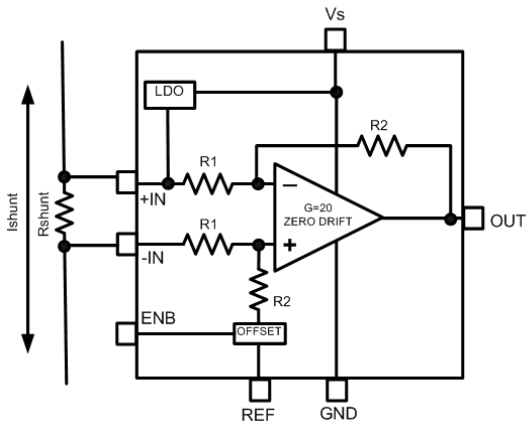


Figure 3. Simplified Schematic

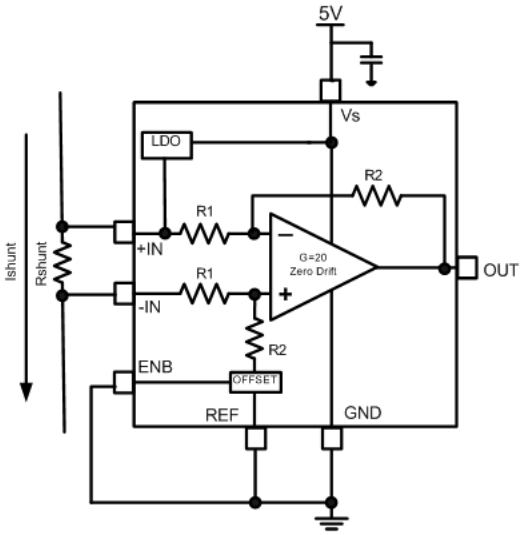
A load current flowing through the external shunt resistor produces a voltage at the input terminals of the AD8217. Internally, this device is set up as a difference amplifier. Resistors R1 and R2 match each other with 0.01% accuracy. The input to output gain of the AD8217 is 20V/V, since R2=1.5MΩ and R1=75kΩ, and the transfer function for a difference amplifier is:

Out = (R2/R1) x (Ishunt x Rshunt) or equivalently

Out = (20) x (Ishunt x Rshunt)

ENABLE PIN

The AD8217 is designed for optimal flexibility and accuracy. It includes an internal 80mV reference, which is enabled by grounding Pin 3. Doing so causes the output voltage to be offset by 80mV. The purpose of this feature is to allow users to measure zero load current through the shunt resistor. In cases where the current is unidirectional, the output would ideally move from 0V to 5V, corresponding to a 0mV to 250mV input differential based on the 5V supply and gain of 20V/V of the AD8217. However, all current sensors are fully rail-to-rail at the output. To provide as much dynamic range as possible, this precision 80mV reference allows the user to set a new zero point, and have a linear input to output relationship, regardless of input differential or common mode voltage. This feature is optimal for unidirectional measurements, and allows for maximum dynamic range. A typical connection diagram for this mode is depicted in the following figure.



The figure above shows the Enable pin activated, and the output starting at 80mV. This new starting point can correspond to the zero load current in the application. The input to output transfer function is shown in the figure below.

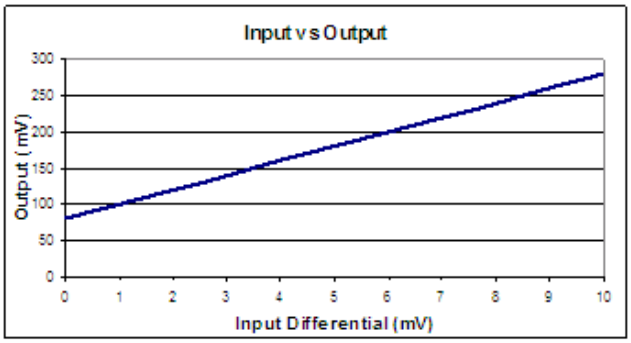
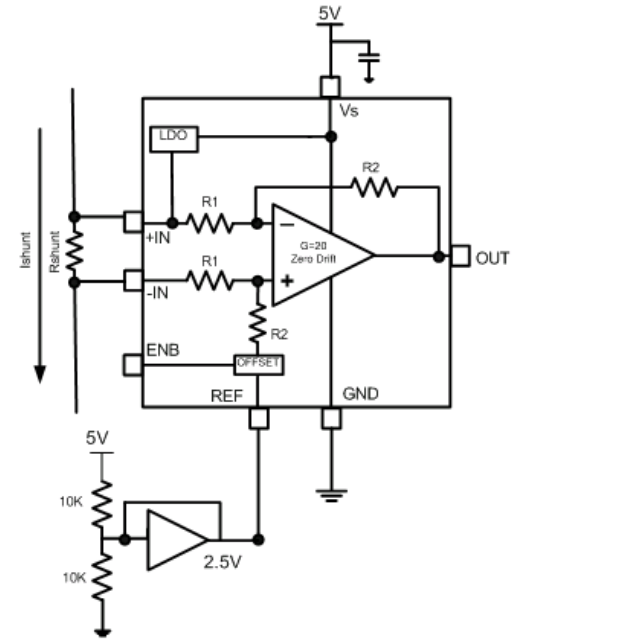


Figure 4. Output offset with Enable pin grounded

If the enable pin is not used, and the application still requires a unidirectional current sensor, the Enable pin can simply be left floating (No Connect). In this mode, the AD8217 still performs very well and the output can typically go as low as 10mV. This low output voltage range will vary with temperature. See specifications table for further information on this mode of operation.

REFERENCE PIN

The AD8217 is also a bidirectional current monitor. Pin 7 can be used to input a low impedance voltage from 0V to 5V, which would correspondingly offset the output with a gain of 1V/V. For example, inputting 2.5V lifts the AD8217 output to 2.5V. Then, bidirectional current measurements can be performed. A typical connection diagram and the corresponding input to output transfer function is shown below.



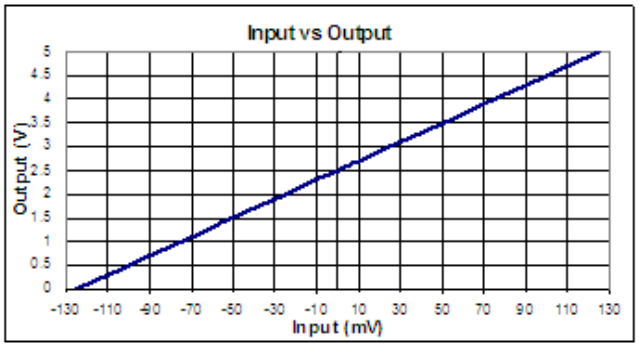


Figure 5. 2.5V reference at pin 7

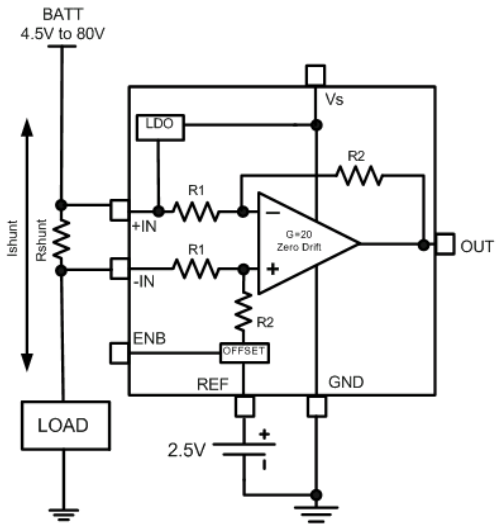
A low impedance voltage at pin 7 is necessary, in order to maintain the high ratio matching of the internal resistors, and the high offset and gain performance of the AD8217.

Alternatively, if this reference pin (Pin 7) is not used, then it should be connected to GND, meaning the output of the AD8217 will start close to 0V.

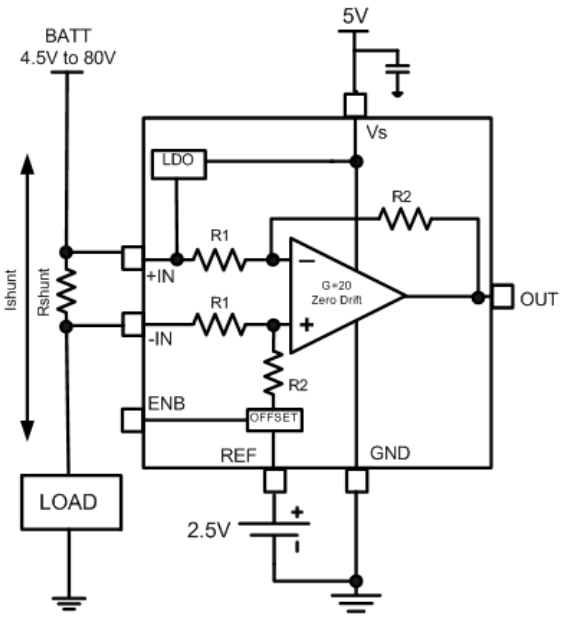
SUPPLY PIN (VS)

The AD8217 has two different modes of operation. The user can connect a supply of 4.5V to 5.5V at Vs (Pin 2) or this pin can simply float (No Connect).

If there is no connection at Vs (Pin 2 floating), then the AD8217 will be powered via the common mode voltage present at Pin 1 (+IN). If the voltage at this pin is 4.5V to 80V, then an internal LDO will supply the AD8217 throughout this common mode range. This connection diagram is depicted below.



The voltage range of Vs (pin 2) is 4.5V to 5.5V, so the user must ensure that no connection exists between the Vs (Pin 2) and +In (Pin 1).



OUTLINE DIMENSIONS

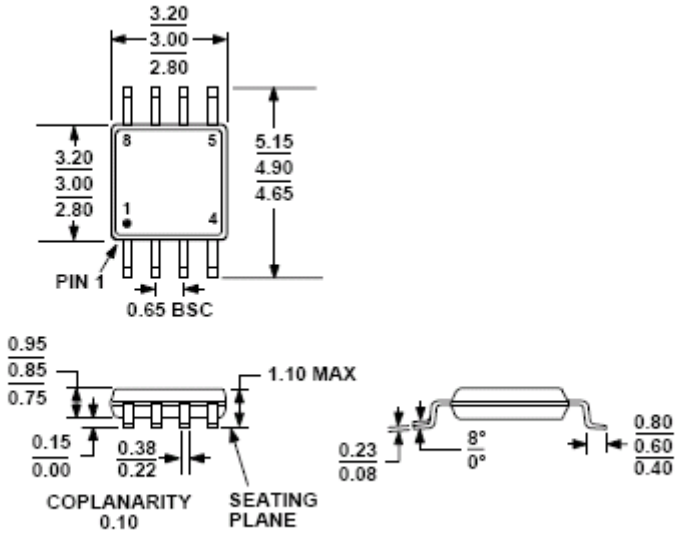


Figure 6. 8-Lead Mini Small Outline Package [MSOP_N]
Narrow Body
(RM-8)
Dimensions shown in millimeters and (inches)

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
AD8217TBDZ[1]	–40°C to +125°C	8-Lead MSOP	RM-8

[1] Z = RoHS Compliant Part.