

## LMP8271, LMP8276

# High Common Mode, Gain of 20, Bidirectional Precision Voltage Difference Amplifiers

### General Description

The LMP<sup>™</sup>8271, LMP8276 are fixed gain differential amplifiers with a -2V to 27V input common mode voltage range and a supply voltage range of 4.5V to 5.5V. The LMP8271, LMP8276 are precision amplifiers which will detect, amplify and filter small differential signals in the presence of high common mode voltages. The gain is fixed at 20 and is adequate to drive an ADC to full scale in most cases. This fixed gain is achieved in two separate stages, a pre-amplifier with gain of +10 and a second stage amplifier with a gain of +2. The internal signal path is brought out on two pins that provide a connection for a filter network.

The LMP8271, LMP8276 will function with reduced specifications over the extended common mode input voltage range of -5 to 36 Volts. This feature makes the device suitable for applications with load dump in automotive systems.

The midrail offset adjustment pin enables the user to utilize this device for bidirectional current sensing. This is achieved by adjusting an externally set voltage reference. Accurate bidirectional load current measurements are achieved when monitoring the output with respect to this reference voltage

### Features

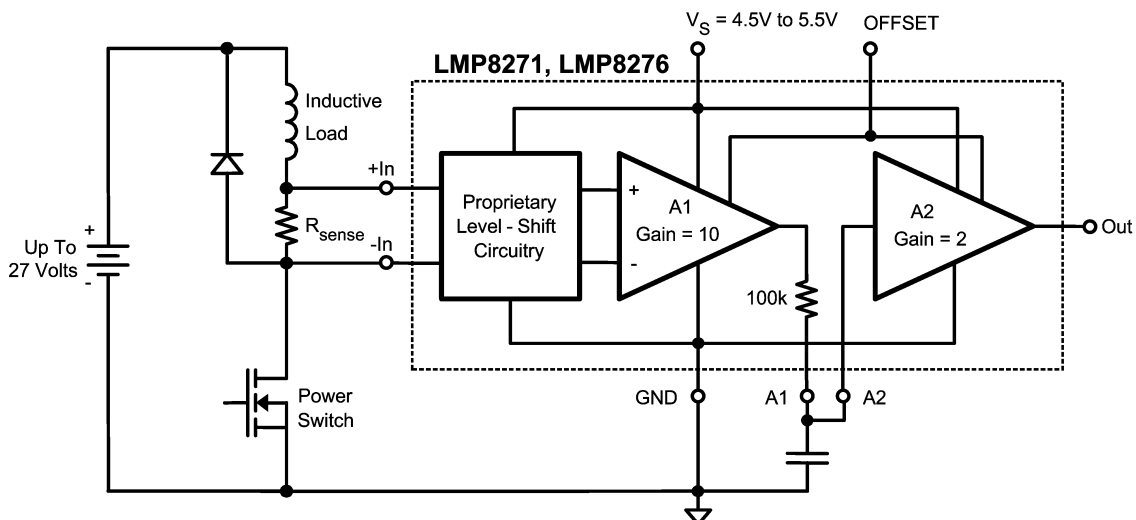
- Bidirectional Current Sense Capability
- Typical Values, TA = 25°C
- Input Offset Voltage 1mV max
- TCVo (LMP8271) 15µV/°C max
- TCVo (LMP8276) 30µV/°C max
- CMRR 80dB Min
- Extended CMVR -5V to 36V
- Output Voltage Swing Rail to Rail
- Bandwidth 80KHz
- Operating Temperature Range (Ambient) -40°C to 125°C
- Operating Temperature Range (bare die) -40°C to 150°C
- Supply Voltage 4.5V to 5.5V
- Supply Current 1mA

### Applications

- Fuel Injection Control
- Low Side Driver Configuration Current Sensing
- Power Management Systems

## Typical Application

Typical Application: Low side Current Sensing



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## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

ESD Tolerance (Note 2)	
Human Body Model	
For input pins only	±4000V
For All other pins	±2000V
Machine Model	200V
Supply Voltage (V <sub>S</sub> - GND)	5.75V

CMVR Continuous	-5 to 42 Volts
Transient (300 ms)	-TBD to 45 Volts
Storage Temperature Range	-65°C to +150°C

Junction Temperature (Note 3)	+150°C max
Soldering Information	
Infrared or Convection (20 sec)	235°C
Wave Soldering Lead Temp. (10 sec)	260°C

## Operating Ratings (Note 1)

Temperature Range (Note 3)	
Packaged devices (Note 3)	-40°C to +125°C
Bare Die Junction Temperature (Note 3)	-40°C to +150°C
Supply Voltage (V <sub>S</sub> - GND)	4.5V to 5.5V
Package Thermal Resistance (θ <sub>JA</sub> ) (Note 3)	
8-Pin SOIC	190°C/W

## 5V Electrical Characteristics (Note 7)

Unless otherwise specified, all limits guaranteed for T<sub>A</sub> = 25°C, V<sub>S</sub> = 5V, GND = 0, -2V ≤ V<sub>CM</sub> ≤ 27V. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min	Typ (Note 4)	Max	Units
V <sub>OS</sub>	Input Offset Voltage	V <sub>CM</sub> = V <sub>S</sub> /2		±0.25	1.0	mV
TC V <sub>OS</sub>	Input Offset Voltage Drift	LMP8271		±6	<b>±15</b>	µV/°C
TC V <sub>OS</sub>	Input Offset Voltage Drift	LMP8276		±6	<b>±30</b>	µV/°C
A2 I <sub>B</sub>	Input Bias Current of A2	(Note 5)			<b>±20</b>	µA
I <sub>S</sub>	Supply Current		0.6 <b>TBD</b>	1.0	1.2 <b>TBD</b>	mA
R <sub>CM</sub>	Input impedance Common Mode		<b>160</b>	200	<b>240</b>	KΩ
R <sub>DM</sub>	Input impedance Differential Mode		<b>320</b>	400	<b>480</b>	KΩ
CMVR	Input Common-Mode Voltage Range	Continuous	<b>-2</b>		<b>+27</b>	V
ECMVR	Extended Common-Mode Voltage Range		-5		36	V
DC CMRR	DC Common Mode Rejection Ratio	-2V ≤ V <sub>CM</sub> ≤ 27V -5V ≤ V <sub>CM</sub> ≤ 36V	<b>80</b> <b>80</b>			dB
AC CMRR	AC Common Mode Rejection Ratio	-2V ≤ V <sub>CM</sub> ≤ 27V -2V ≤ V <sub>CM</sub> ≤ 27V		TBD TBD		dB
PSRR	Power Supply Rejection Ratio	4.5V ≤ V <sub>S</sub> ≤ 5.5V	TBD <b>TBD</b>			dB
R <sub>F-INT</sub>	Filter Resistor		<b>97</b>	100	<b>103</b>	KΩ
TCR <sub>F-INT</sub>	Filter Resistor Drift			TBD		ppm/°C
	Midscale Offset Scaling Accuracy (Pin 7)				1	%
A <sub>V</sub>	Total Gain			20		V/V
	Gain Error				±1	%
	Gain Drift				<b>±25</b>	ppm/°C
A1 V <sub>OUT</sub>	A1 Output Voltage Swing	R <sub>L</sub> = 100KΩ on Output				
					<b>0.01</b>	Volts
				<b>4.80</b>		
A2 V <sub>OUT</sub>	A2 Output Voltage Swing	R <sub>L</sub> = 100KΩ on Output				
					<b>0.01</b>	Volts
				<b>4.80</b>		

## 5V Electrical Characteristics (Note 7) (Continued)

Unless otherwise specified, all limits guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $\text{GND} = 0$ ,  $-2\text{V} \leq V_{\text{CM}} \leq 27\text{V}$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min	Typ (Note 4)	Max	Units
SR	Slew Rate (Note 6)			0.7		V/ $\mu\text{s}$
BW	Bandwidth			80		KHz
Noise	0.1Hz to 10Hz			TBD		$\mu\text{Vpp}$
	Spectral Density			TBD		nV/ $\sqrt{\text{Hz}}$

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics Tables.

**Note 2:** Human body model, 1.5 k $\Omega$  in series with 100 pF. Machine model: 0 $\Omega$  in series with 200 pF.

**Note 3:** The maximum power dissipation is a function of  $T_{\text{J(MAX)}}$ ,  $\theta_{\text{JA}}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{\text{J(MAX)}} - T_A) / \theta_{\text{JA}}$ . All numbers apply for packages soldered directly onto a PC board.

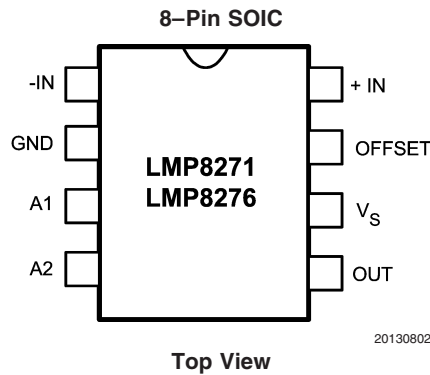
**Note 4:** Typical values represent the most likely parametric norm.

**Note 5:** Positive current corresponds to current flowing into the device.

**Note 6:** Slew rate is the average of the rising and falling slew rates.

**Note 7:** Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

## Connection Diagram



## Application Note

The LMP8271, LMP8276 are single supply amplifier with a fixed gain of 20 and an extended common mode voltage range of -2V to 36V. The fixed gain is achieved in two separate stages, a pre-amplifier with gain of +10 and a second stage amplifier with gain of +2. A block diagram of the LMP8271, LMP8276 is shown in Figure 1.

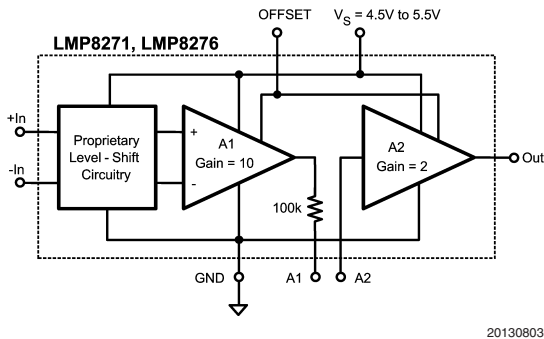


FIGURE 1.

The overall offset of the LMP8271, LMP8276 is minimized by trimming amplifier A1. This is done so that the output referred offset of A1 cancels the input referred offset of A2 or  $10V_{\text{OS1}} = -V_{\text{OS2}}$

Because of this offset voltage relationship, the offset of each individual amplifier stage maybe more than the limit specified for the overall system in the datasheet tables. Care must be given when pin 3 and 4, A1 and A2, are connected to each other. If the signal from A1 to A2 is amplified or attenuated (by use of amplifiers and resistors), the overall LMP8271, LMP8276 offset will be affected as a result. Filtering the signal between A1 and A2 or simply connecting the two pins will not change the offset of the LMP8271, LMP8276.

Referencing input referred offset voltages, the following relationship holds:

$$\frac{(10V_{\text{OS1}}) + (V_{\text{OS2}})}{10} = V_{\text{OS}}(\text{LMP8271, LMP8276})$$

If the signal on pin 3 is scaled, attenuated or amplified, by a factor **X** then the offset of the overall system will become:

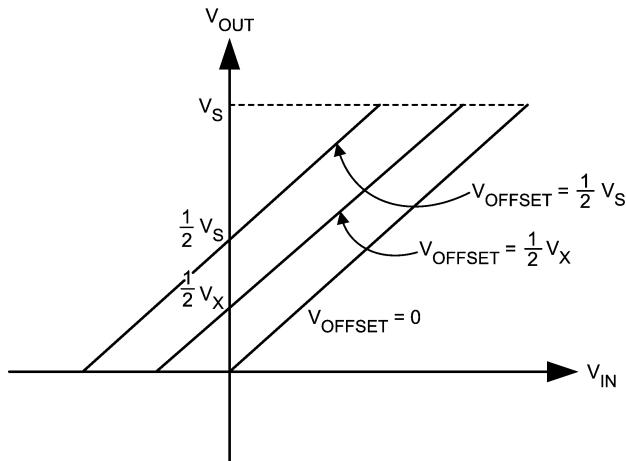
## Application Note (Continued)

$$\frac{(10V_{OS1}) \cdot (X) + (V_{OS2})}{10} = V_{OS}(\text{LMP8271, LMP8276})$$

This represents a value that the LMP8271 and LMP8276 have not been optimized and trimmed for and may very well be above the limits indicated in the electrical characteristics tables.

### Midrail Offset Adjustment Pin

The external midrail offset adjustment pin enables the user to utilize this device for bidirectional current sensing. If the offset pin, pin 7, is connected to ground then the LMP8271, LMP8276 are capable of sensing positive signals. When the offset pin is connected to  $V_S$  then  $1/2V_S$  is added to the output and under this condition the amplifier can sense both positive and negative signals. If this offset pin is connected to any voltage between ground and  $V_S$ , then the output is increased by a voltage equal to half of that offset, e.g. If the offset is connected to  $V_X$ , then the output increases by  $1/2V_X$ . The following figure shows how this works:



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FIGURE 2.

Note that the offset pin, pin 7, needs to be connected at all times. If the pin is left floating, the LMP8271 and LMP8276 will be operating in an undefined mode. Also pin 7 should be driven from a low impedance source.

## Notes

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 Tel: 1-800-272-9959

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 Email: [europe.support@nsc.com](mailto:europe.support@nsc.com)  
 Deutsch Tel: +49 (0) 69 9508 6208  
 English Tel: +44 (0) 870 24 0 2171  
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**Asia Pacific Customer**  
**Support Center**  
 Email: [ap.support@nsc.com](mailto:ap.support@nsc.com)

**National Semiconductor**  
**Japan Customer Support Center**  
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