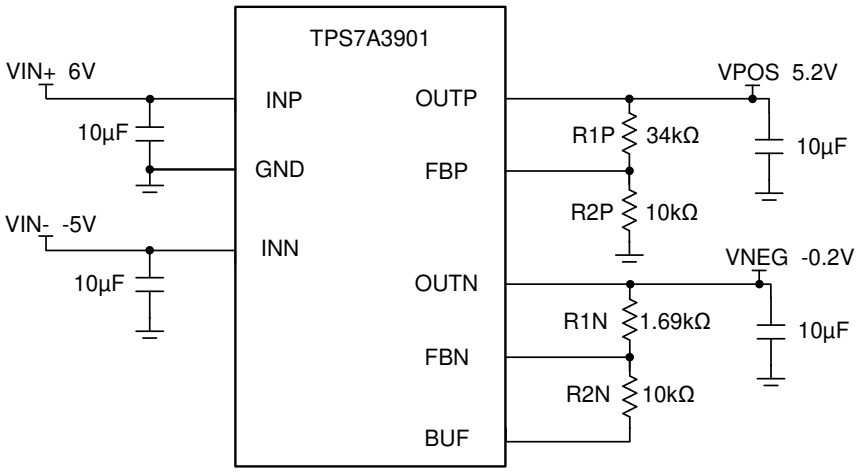
Analog Engineer's Circuit

Powering a dual-supply op-amp circuit with one LDO

LDO Input	LDO Output	Output Noise Level
Vin+ > 6V	5.2V	27µVRMS
Vin– < –5V	–200mV	22µVRMS

Design Description

This design shows a power supply that can be used to create a positive operational-amplifier (op amp) supply and a small negative op-amp supply. This small negative voltage is adjustable and is necessary in many operational amplifiers to verify linearity down to ground. This design shows the TPS7A3901 as the power supply for creating the positive and negative voltage rails for operational amplifier circuits. This low dropout regulator (LDO) differs from most in the ability to regulate small negative voltages, as the following image shows. This is a generic circuit implementation that can be used in many *Industrial* applications.



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Specifications

Measured Performance of ADS8900B With LDO

Parameter	Test Condition	Data Sheet Specification	Measured ADS8900B Performance
SNR	Vin_max = 5V, Vin_min = 0V	104.5dB	102.2dB
THD	Vin_max = 5V, Vin_min = 0V	–125dB	–123.5dB

Design Notes

1. Determine the linear range of the op amp based on common mode, output swing, and linear open-loop gain specification.
2. Set the adjustable LDO outputs to match the linear range of op amp.
3. Select X7R capacitors according to the temperature performance.
4. In cases where a negative supply is not available, an alternative method is to use a *Low Noise Negative Bias Generator* (LM7705).

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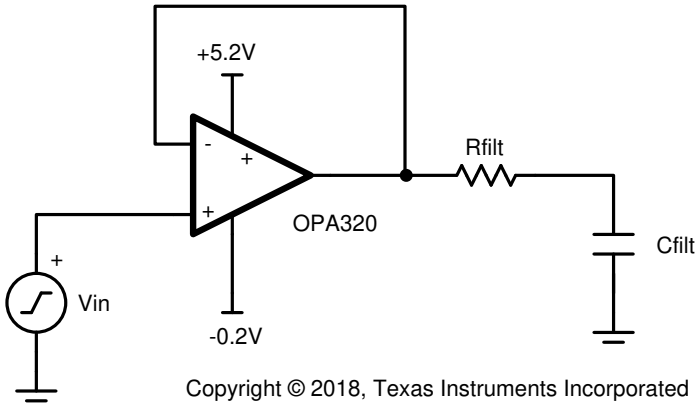
Component Selection

1. A common configuration shows in the following image using an OPA320 in a buffer configuration with a 0V to 5V desired linear signal swing. The power supplies are both 200mV away from the desired input and output swing. This topology makes sure of linear input and output swing for this amplifier.



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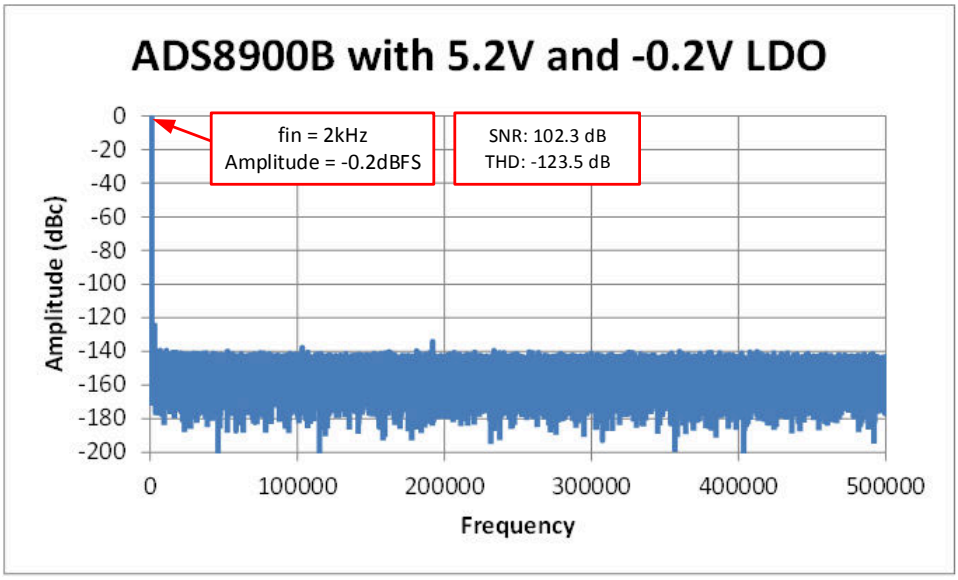
2. Select the components for the adjustable LDO outputs. Using the previous OPA320 example, the rails for the system are –200mV and +5.2V.

Desired Output	R1	R2
+5.2V	34kΩ	10kΩ
–200mV	1.69kΩ	10kΩ

ADS8900B 20-Bit FFT Taken With LDO Adjusted to 5.2V and –0.2V

The FFT in the following was measured with an input signal very near full scale ±5V (–0.2dBFS). Note that the SNR and THD is very good compared to the case where the supply is adjusted to 5V and GND. Note the TPS7A3901 is a convenient way to generate a linear –0.2-V supply.



ADS8900B 20-Bit FFT Taken With LDO Adjusted to 5.0V and GND

The FFT shown in the following image was measured with an input signal very near full scale ±5V (–0.2dBFS). Note that the SNR and THD is poor compared to the case where the supply is adjusted to 5.2V and –0.2V.

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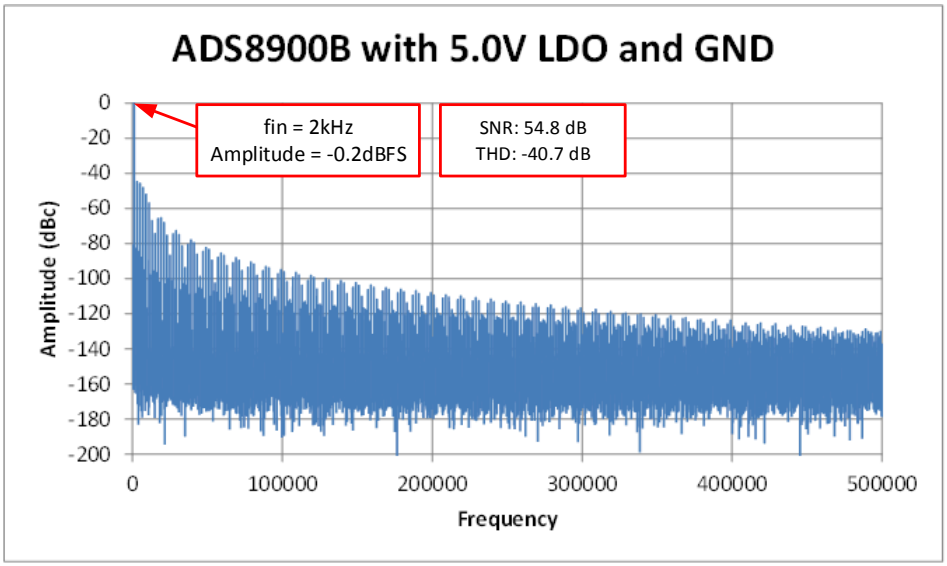

Design Featured Devices

Device	Key Features	Link	Similar Devices
TPS7A3901	The TPS7A39 device is a dual, monolithic, high-PSRR, positive and negative low-dropout (LDO) voltage regulator capable of sourcing (and sinking) up to 150mA of current. The device has a wide output voltage range of 1.2V to 30V for the positive output and –30V to 0V for the negative output. This device is an excellent choice for generating a small negative supply voltage that is useful in cases where a single-supply amplifier needs a small negative supply so that the output can linearly swing to 0V.	www.ti.com/product/TPS7A39	www.ti.com/product/LM7705 (1)
ADS8900B	Bipolar differential inputs, SAR ADC with internal reference buffer, SPI interface	www.ti.com/product/ADS8900B	www.ti.com/adcs
OPA320	Precision, Zero-Crossover, 20Mhz, RRIO, CMOS Operational Amplifier	www.ti.com/product/opa320	www.ti.com/opamp

(1) The LM7705 is another option for a negative voltage supply and is not an LDO regulator, but instead the device is a switched-capacitor regulator.

Design References

See *Analog Engineer's Circuit Cookbooks* for TI's comprehensive circuit library.

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Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (March 2019) to Revision B (September 2024) **Page**

- Updated the format for tables, figures, and cross-references throughout the document..... 1

Changes from Revision * (February 2018) to Revision A (March 2019) **Page**

- Downstyle the title and changed title role to 'Data Converters'. Added link to circuit cookbook landing page... 1

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