Analog Engineer's Circuit

Isolated Power Supply, Low-Noise Circuit: 5V, 100mA

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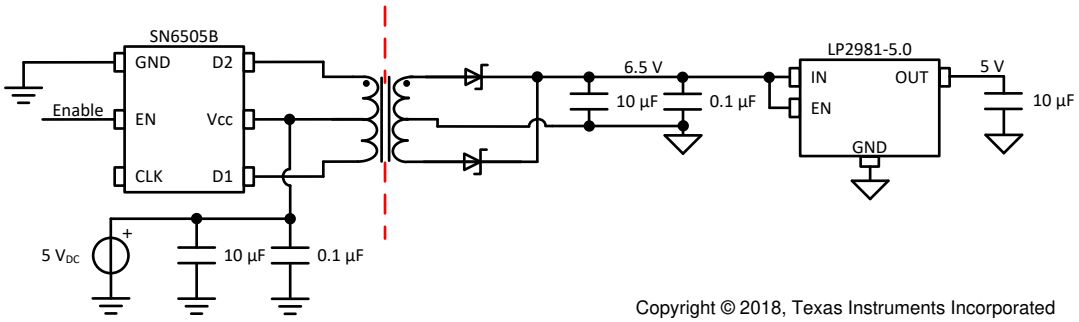
Power Supplies

AVDD	Vee	Vdd
5.0V	6.5V	5.0V

Design Description

This design shows an isolated power supply using a transformer driver and a low dropout regulator (LDO). This design is intended to be combined with a digitally-isolated SAR ADC, such as in a *Digitally-Isolated ADS8689 Design*. *Industrial applications* that require an isolation interface are the primary application for this design in combination with a SAR ADC. The transformer driver and LDO can be selected differently based on the output current requirements and output voltage noise requirements. This power supply was built and tested on a PCB with the ADS8689 and later in this document the performance of the ADS8689 is shown to prove the effectiveness of the power supply.

This circuit implementation is applicable in applications such as *analog input modules*, *electrocardiograms (ECGs)*, *pulse oximeters*, and *bedside patient monitors*.



Specifications

Specifications

Specification	Goal	Measured
LDO Output Current	< 100mA	16mA per channel
LDO Output Voltage Noise	< 1mV$_{RMS}$	N/A
ADS8689 Signal-to-Noise Ratio (SNR)	92dB	92.4dB
ADS8689 Total Harmonic Distortion (THD)	–112dB	111.3dB

Design Notes

1. Determine the supply current that is needed on the secondary side of the transformer. This information is used for component selection.
2. Choosing the transformer and transformer driver are very important to creating a correct isolated power supply.
3. The CLK pin on the SN6505B connects to an external clock or left floating to use the internal 420-kHz clock.

Component Selection

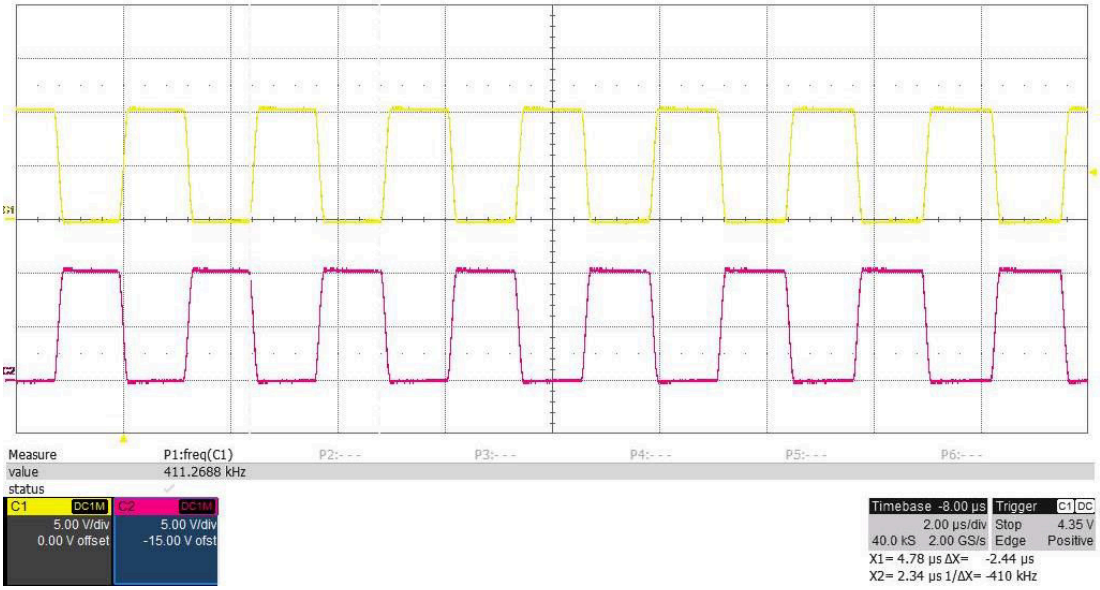
1. Select a transformer driver based on the required output current.
   - SN6505 will provide up to 1A of output current. The SN6505A has a 160-kHz internal clock and the SN6505B has a 420-kHz internal clock.
   - SN6501 will provide up to 350mA of output current.
2. Select a transformer with the desired turns ratio and current rating.
   - This design takes 5-V input and produces 6.5-V output. The turns ratio is determined as shown in the following:

$$\frac{n_p}{n_s} = \frac{V_{IN}}{V_{OUT}} = \frac{5V}{6.5V} = \frac{1}{1.3} \quad (1)$$

   - The 760390014 from Wurth Electronics was used in this design since it has a 1:1.3 turns ratio and a current rating that meets the 100-mA design specification.
3. Select a low dropout regulator (LDO) to use the transformer output and produce a low-noise supply voltage.
   a. Select the LDO to meet the output current requirement of the system and output voltage noise requirement of the system.
   b. The LP2981-5.0 is a fixed output voltage LDO that was selected for this design. This LDO is able to provide 100mA of output current. Also, the LDO output is accurate with only 160µV_{RMS} of output voltage noise.
4. Select the rectifier diodes for the fast switching of the SN6505B.
   - The *SN6505x Low-Noise 1-A Transformer Drivers for Isolated Power Supplies* data sheet recommends using low-cost Schottky rectifier MBR0520L.
   - The forward voltage drop will take away from the output voltage of your isolated power supply.
   - The diodes must be rated for the expected current level for this supply.

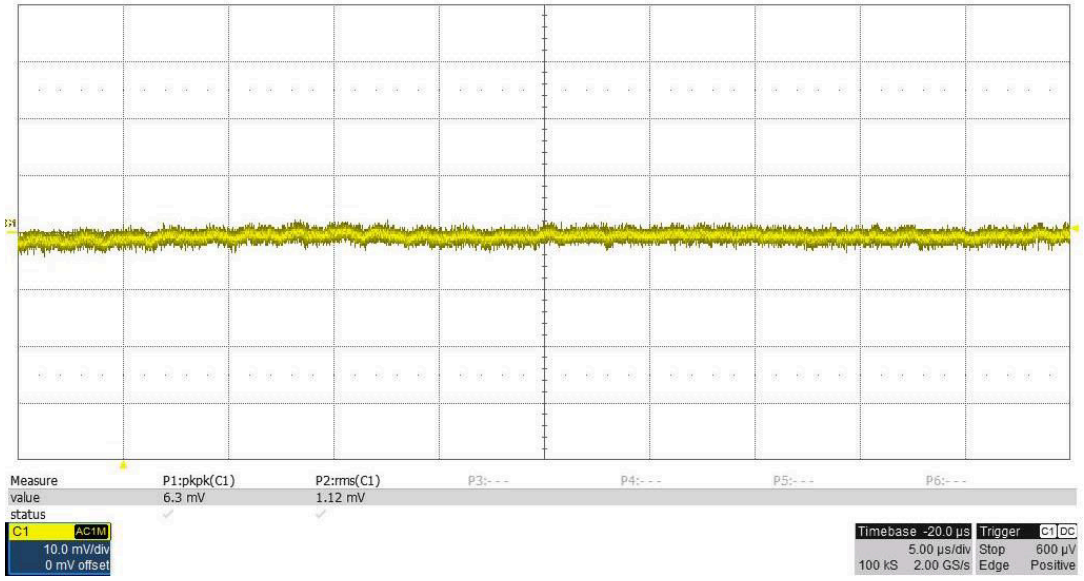
Measured Transformer Driver Outputs

The following image is an oscilloscope capture of the two transformer drive lines from the SN6505B. These are 0V to 5V pulses at a frequency of 411kHz.



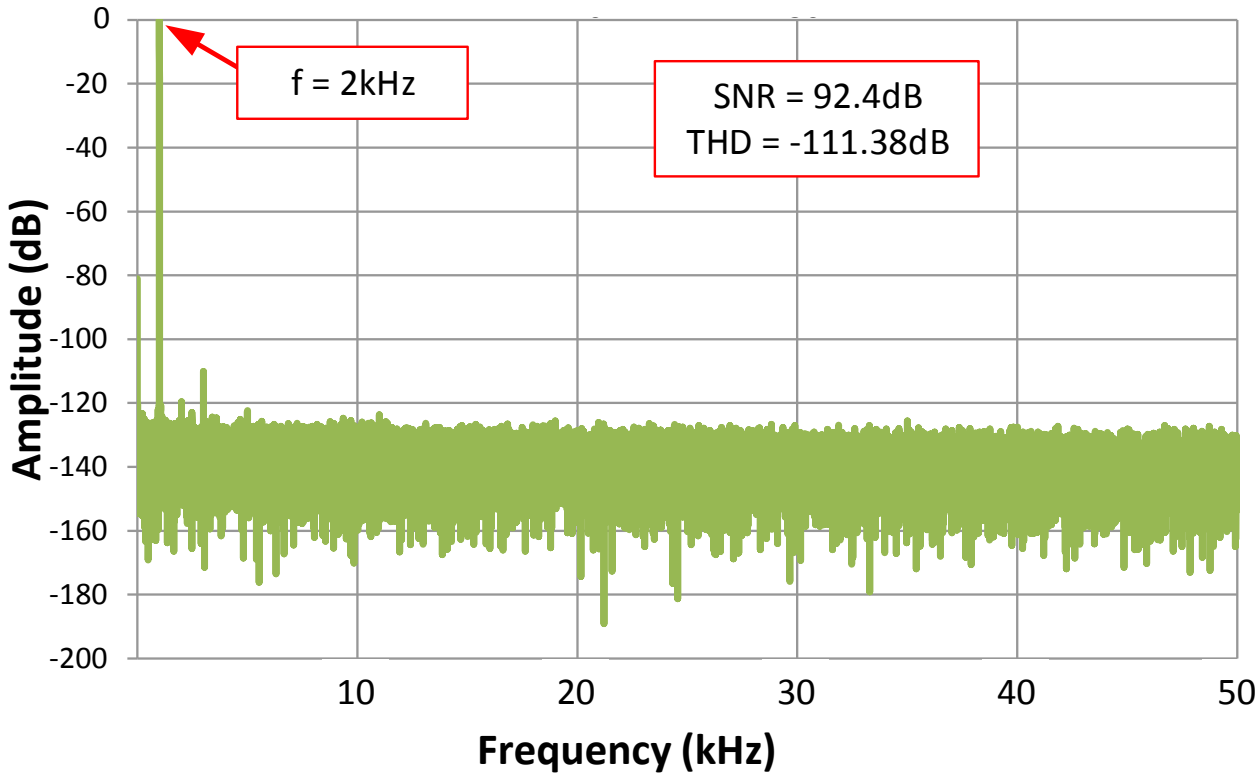
Measured SN6505B Stage Output Ripple

The following image is an oscilloscope capture of the output voltage following the rectifiers of the SN6505B power stage. This is the input to the LP2981-5.0 LDO. Result: 1.12mV_{RMS}.



Measured FFT

This power supply was implemented on a channel-to-channel isolated ADS8689 PCB. Measuring the AC performance of the ADS8689 proves the effectiveness of this isolated power supply. The AC performance indicates SNR = 92.4dB and THD = –111.3dB, which matches well with the specified performance of the ADC: SNR = 92dB and THD = –112dB).



Design Featured Devices

Device	Key Features	Link	Similar Devices
ADS8689	12-bit resolution, SPI, 1-Msps sample rate, single-ended input, AVDD/Vref input range 1.6V to 3.6V.	16-Bit, 100kSPS, 1-Ch SAR ADC with programmable (±12/±10/±6/±5/±2.5V) input ranges on +5V supply	Analog-to-digital converters (ADCs)

(continued)

Device	Key Features	Link	Similar Devices
SN6505B	Low-Noise 1A, 420-kHz transformer driver	Low-noise, 1A, 420-kHz transformer driver with soft start for isolated power supplies	Transformer drivers
LP2981	100mA ultra-low dropout regulator with shutdown	100mA, 16V, low-dropout voltage regulator with enable	Linear and low-dropout (LDO) regulators

Trademarks

All trademarks are the property of their respective owners.

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 and added link to circuit cookbook landing page.....1

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