

## Isolated power supply, low-noise circuit: 5V, 100mA

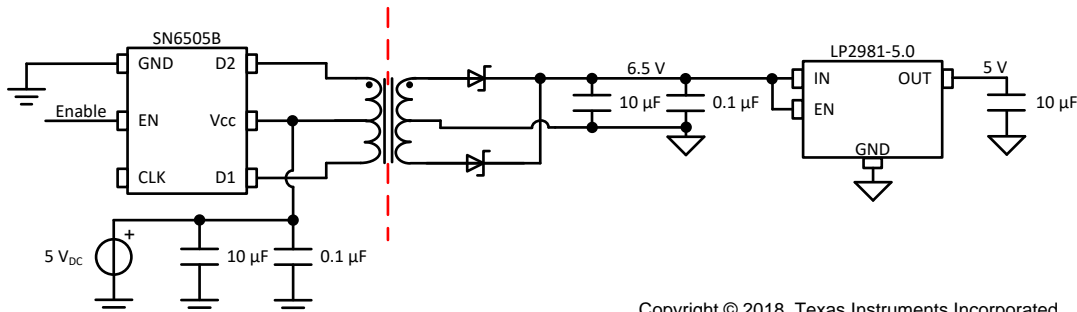
Reed Kaczmarek

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 [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](#), [Electrocardiogram \(ECG\)](#), [Pulse Oximeters](#), and [Bedside Patient Monitors](#).



Copyright © 2018, Texas Instruments Incorporated

## Specifications

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

## Design Notes

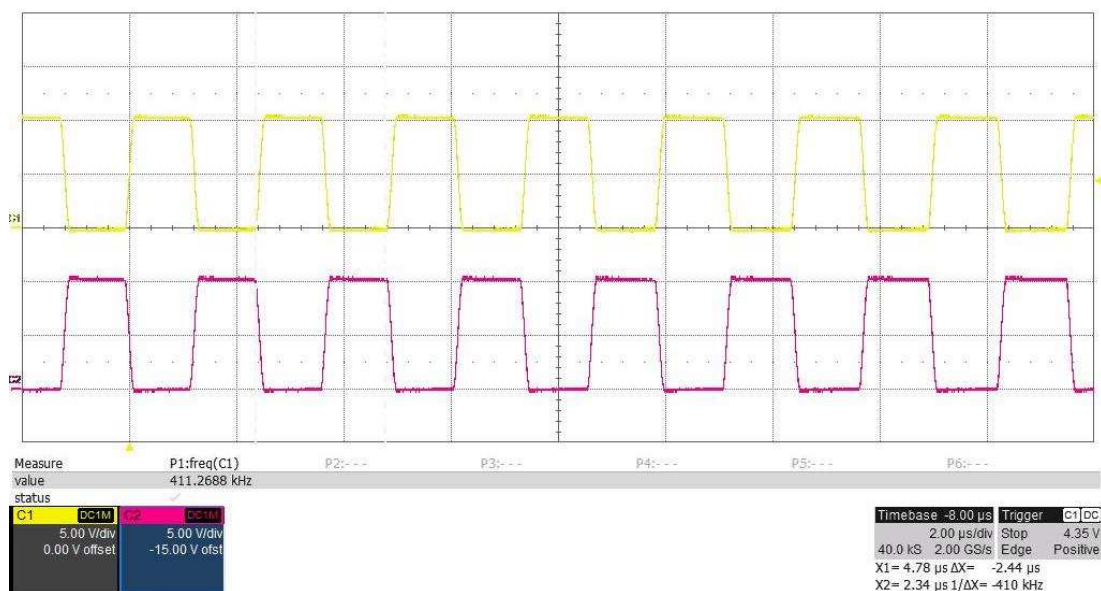
1. Determine the required supply current that is needed on the secondary side of the transformer. This information is used for component selection.
2. Choosing the transformer and transformer driver are very important to creating a correct isolated power supply.
3. The CLK pin on the SN6505B can be connected 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 Würth 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. The LDO should be selected 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<sub>RMS</sub> 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.

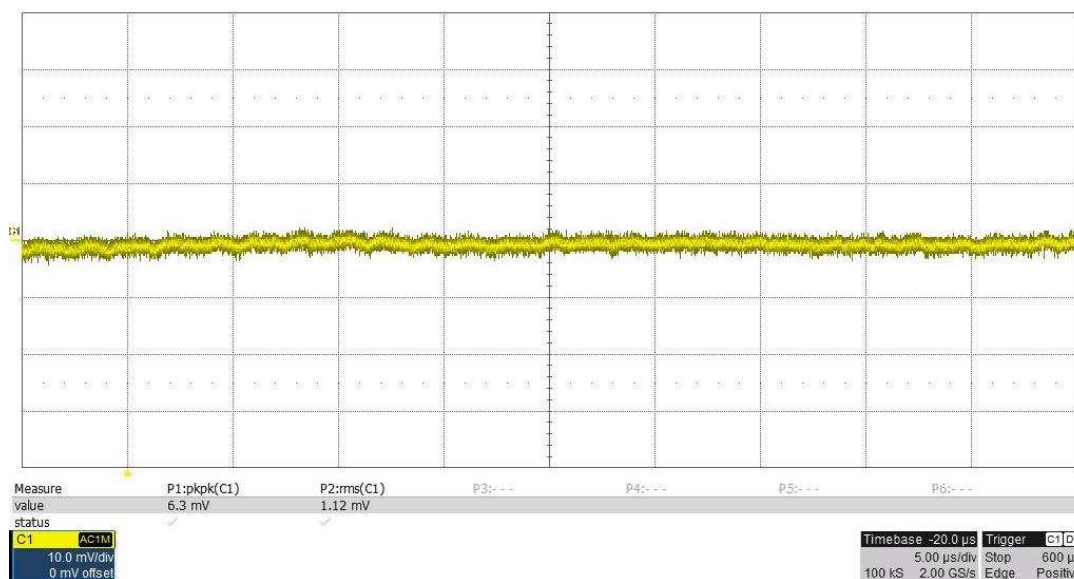
## Measured Transformer Driver Outputs

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.



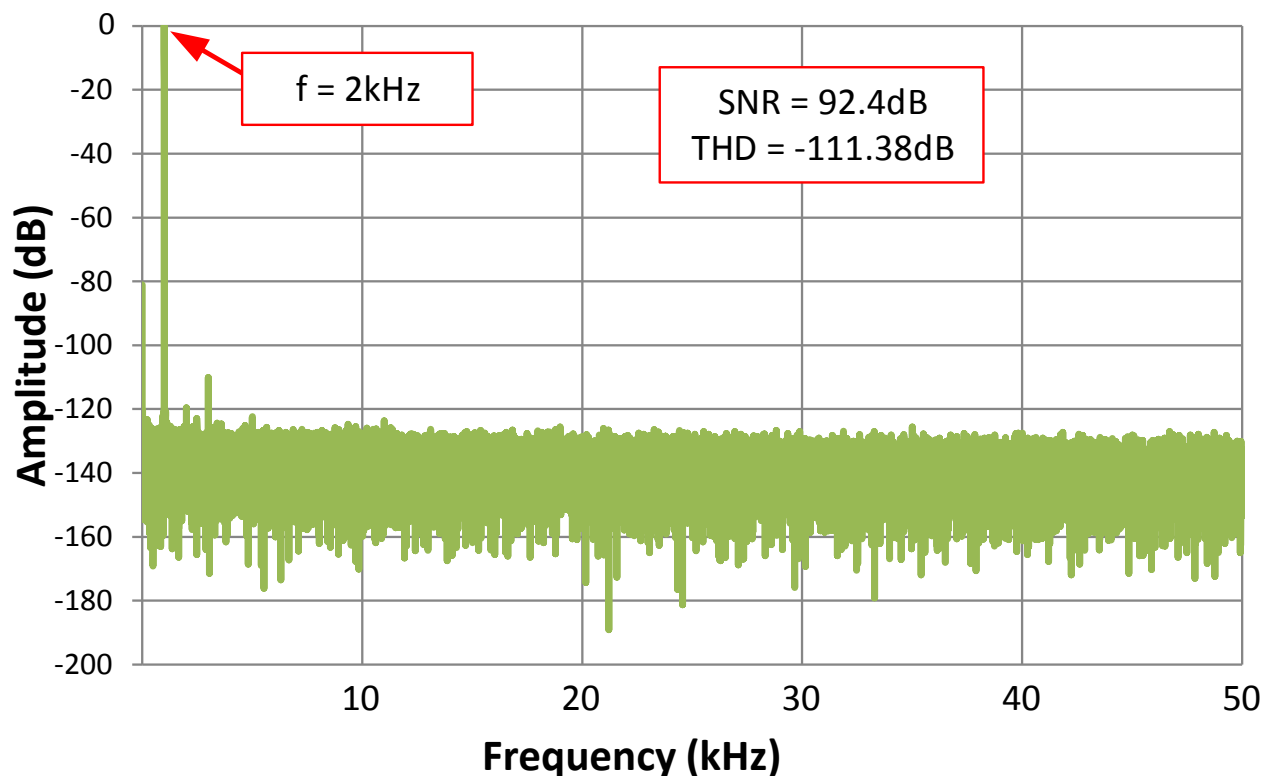
## Measured SN6505B Stage Output Ripple

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<sub>RMS</sub>.



## 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
<a href="#">ADS8689</a>	12-bit resolution, SPI, 1-Msps sample rate, single-ended input, AVDD/Vref input range 1.6V to 3.6V.	<a href="http://www.ti.com/product/ADS8689">www.ti.com/product/ADS8689</a>	<a href="http://www.ti.com/adcs">www.ti.com/adcs</a>
<a href="#">SN6505B</a>	Low-Noise 1-A, 420-kHz transformer driver	<a href="http://www.ti.com/product/SN6505B">www.ti.com/product/SN6505B</a>	<a href="http://www.ti.com/isolation/transformer-driver/products.html">www.ti.com/isolation/transformer-driver/products.html</a>
<a href="#">LP2981</a>	100mA ultra-low dropout regulator with shutdown	<a href="http://www.ti.com/product/LP2981">www.ti.com/product/LP2981</a>	<a href="http://www.ti.com/ldo">www.ti.com/ldo</a>

## Design References

See [Analog Engineer's Circuit Cookbooks](#) for TI's comprehensive circuit library.

## Revision History

Revision	Date	Change
A	March 2019	Downstyle the title and changed title role to 'Data Converters'. Added link to circuit cookbook landing page.

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](http://ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2021, Texas Instruments Incorporated