



# Power supplying for noise sensitive signal chain

Oct 2025

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# Ultra Low Noise Regulator

[analog.com](http://analog.com)



# Analog Devices – Performance LDO Leader

**Highest PSRR** – Rejects power supply noise from affecting sensitive analog loads

- High accuracy sensors for flow meters, gas detection, etc...

**Lowest noise** – low spot noise as well as low integrated noise when converting a voltage

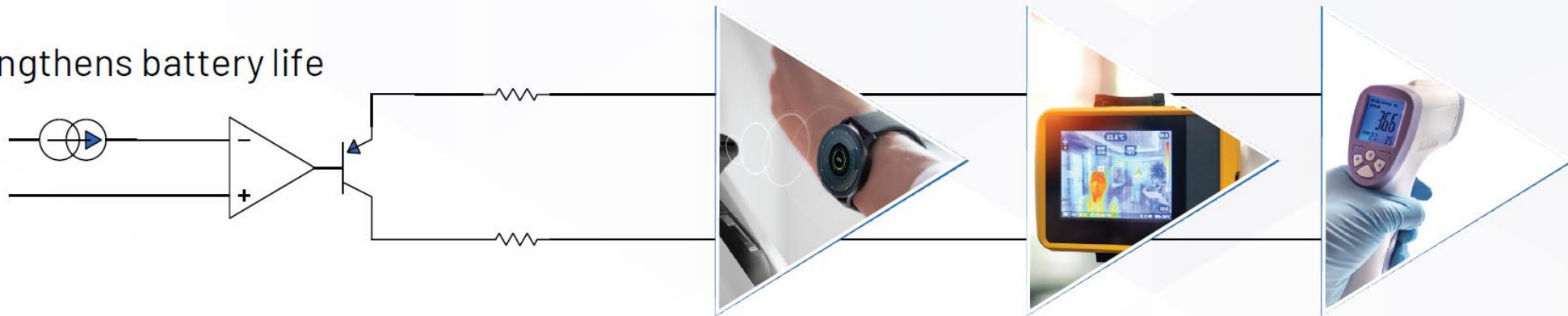
- Low noise maintains performance for sensitive applications, ultrasound, audio amplifiers, etc...

**Wide input voltage range** – supports various applications where input supply can vary

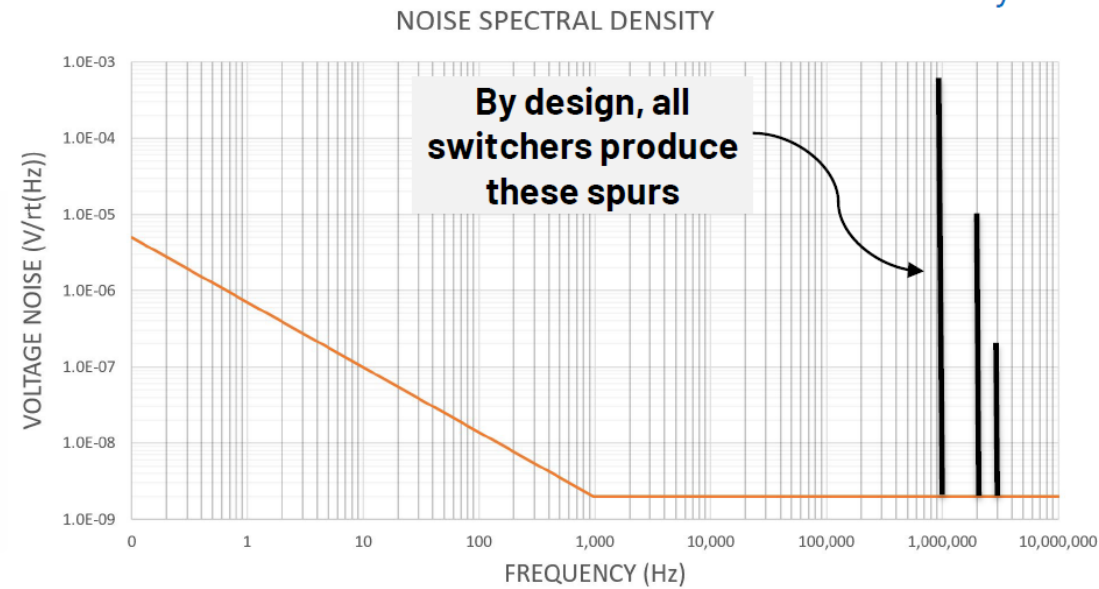
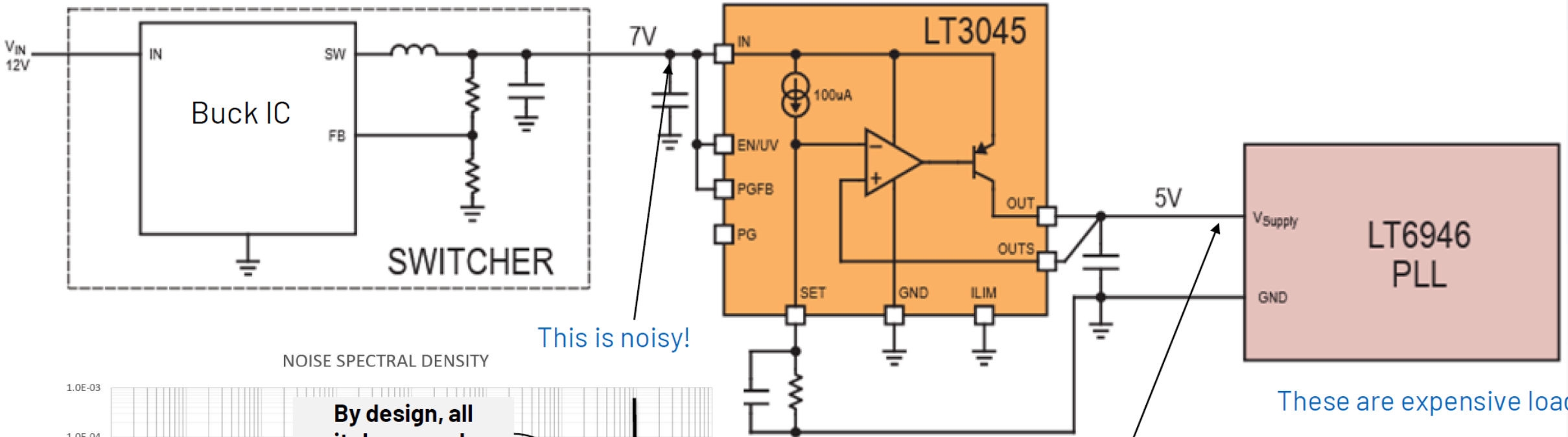
**Low Dropout Voltage** – allows for operation with a smaller input to output voltage ratio

- Maximizes efficiency, reducing heat loss, for battery powered, energy sensitive applications

**Low  $I_o$**  – lengthens battery life



# Why Low Noise and High PSRR Supplies?

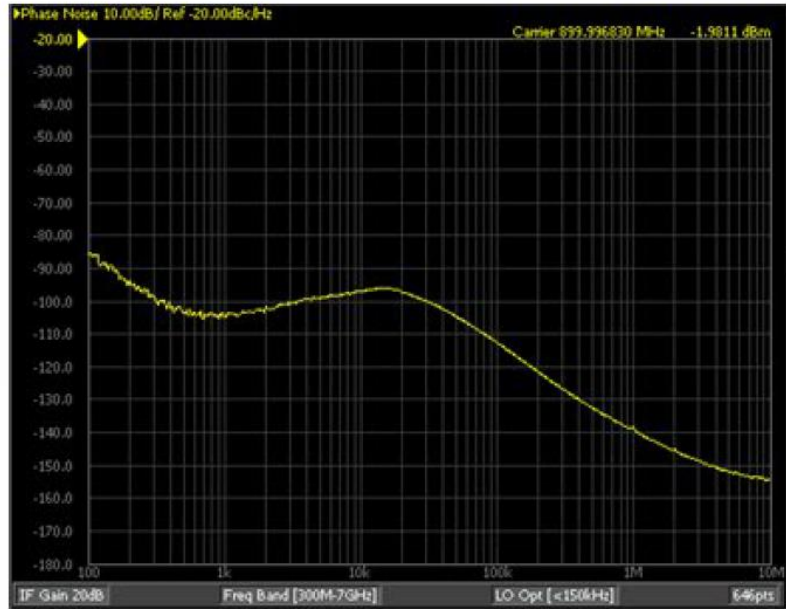


This is noisy!

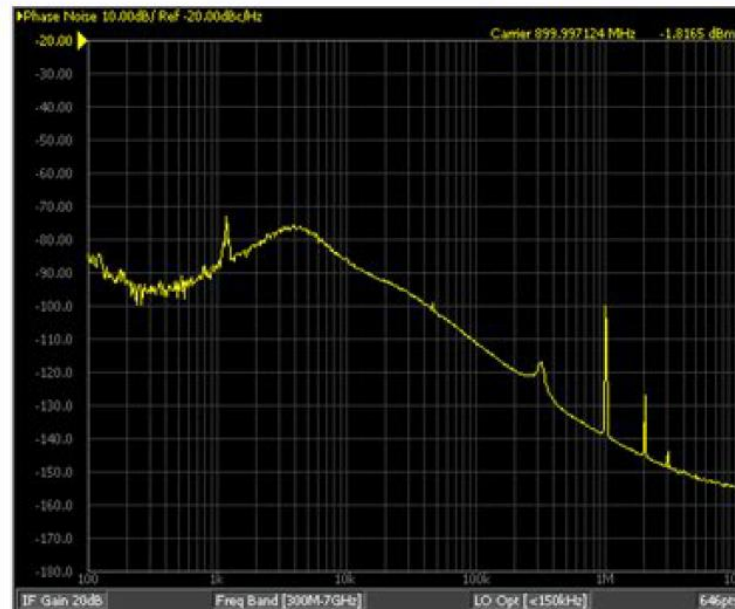
This needs to be super clean!  
 Either a High PSRR ULN LDO or a ULN Buck regulator + LC filtering is required.

These are expensive loads \$\$  
 Could be any noise sensitive load: ADCs, DACs, PLLs, RF Transceivers, Amplifiers, References, Image Sensors

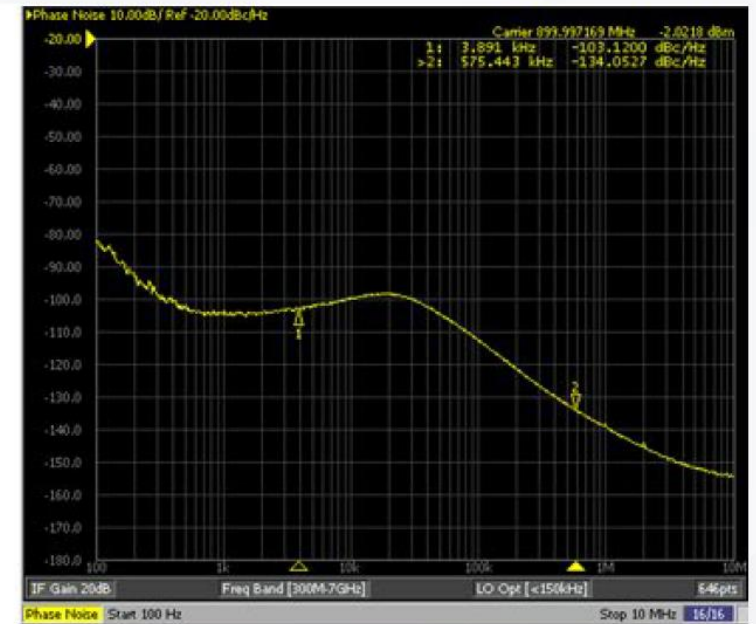
# Powering the LTC6946-3 PLL



PLL directly powered using a linear bench supply + a lot of passive filtering

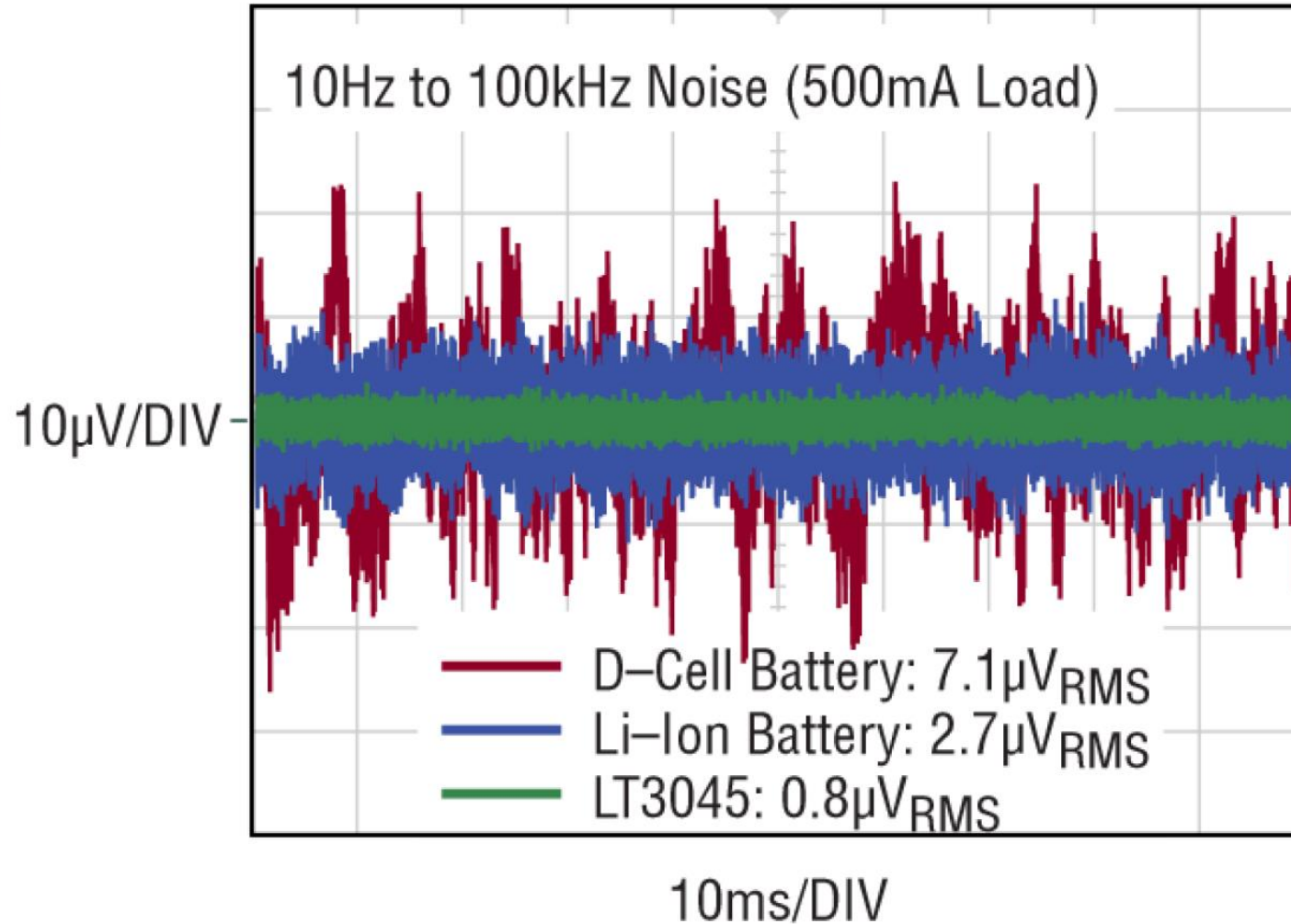


PLL directly powered using a switching supply with 300uF Bypass Capacitor at PLL Input.



PLL powered using LT3045 post-regulating a switcher with no Bypass Capacitor at PLL Input.

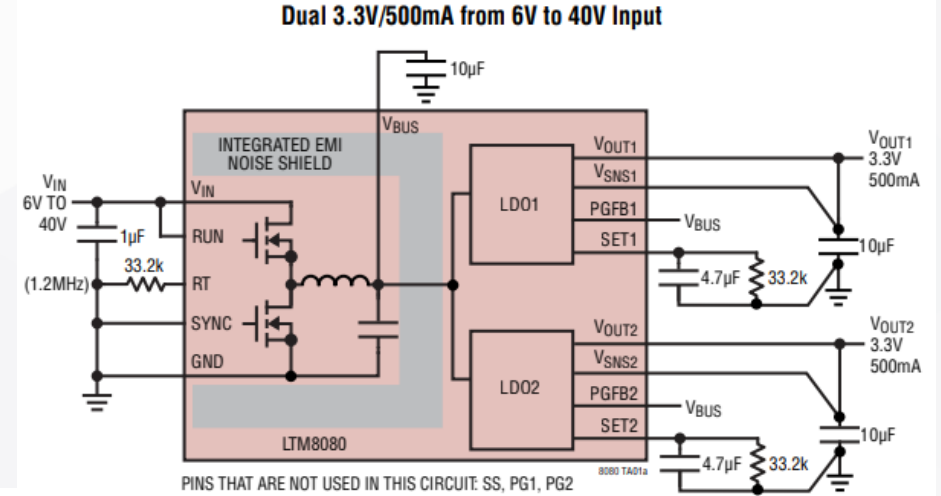
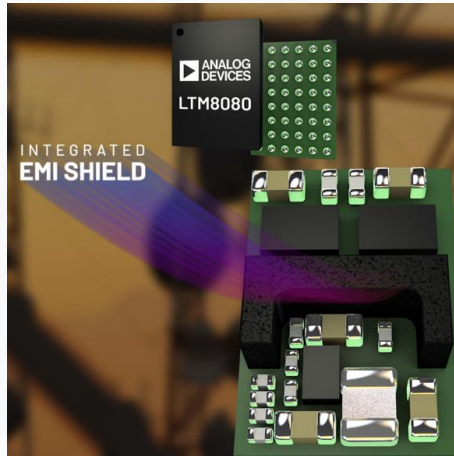
# LT3045: Lower Noise Than Batteries!



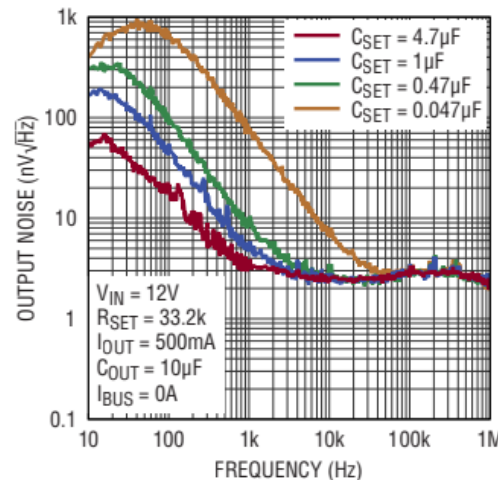
# LTM8080: 40V<sub>IN</sub>, Dual 500mA or Single 1A Ultralow Noise, Ultrahigh PSRR $\mu$ Module Regulator

## FEATURES

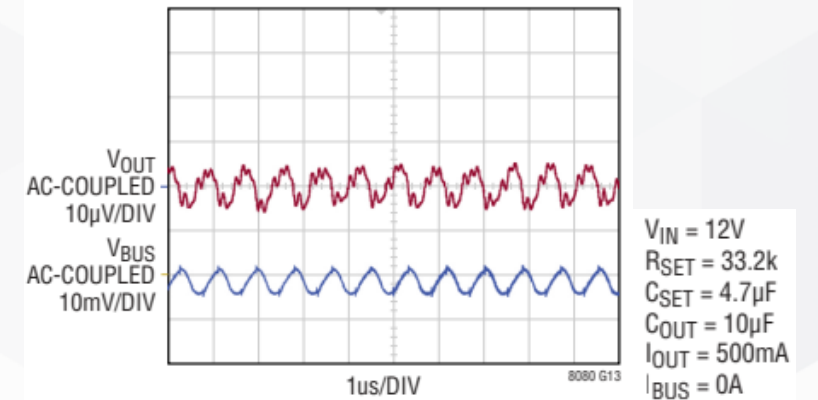
- Dual LDOs Powered by an Integrated Switching Step-Down Regulator
- Low Noise Silent Switcher® Architecture with an Integrated EMI Noise Shield
- CISPR22 Class B and CISPR25 Class 5 Compliant
- Ultralow Output RMS Noise:  $<1\mu\text{V}_{\text{RMS}}$  (10Hz to 100kHz)
- Ultralow Output Spot Noise:  $2\text{nV}/\sqrt{\text{Hz}}$  at 10kHz
- Ultrahigh PSRR: 80dB at 100kHz
- Wide Input Voltage: 3.5V to 40V
- Wide Output Voltage: 0V to 8V
- Dual 500mA Continuous Current at  $T_A = 85^\circ\text{C}$
- Voltage Tracking Function to Minimize Power Loss
- 100 $\mu\text{A}$  SET Pin Current with  $\pm 1\%$  Initial Accuracy
- Selectable Switching Frequency: 200kHz to 2.2MHz
- External Synchronization
- Programmable Power Good
- Parallelable for Lower Noise and Higher Current
- 9mm  $\times$  6.25mm  $\times$  3.32mm BGA



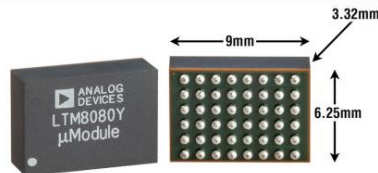
Noise Spectral Density



$V_{\text{OUT}n}$  Noise Waveform (100kHz BW)



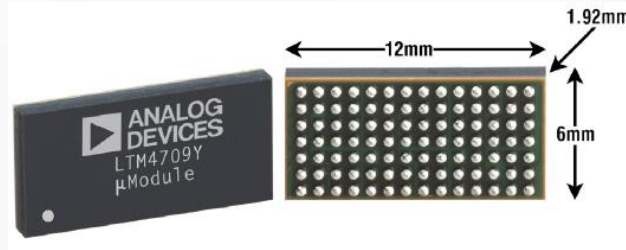
LTM8080  
Video



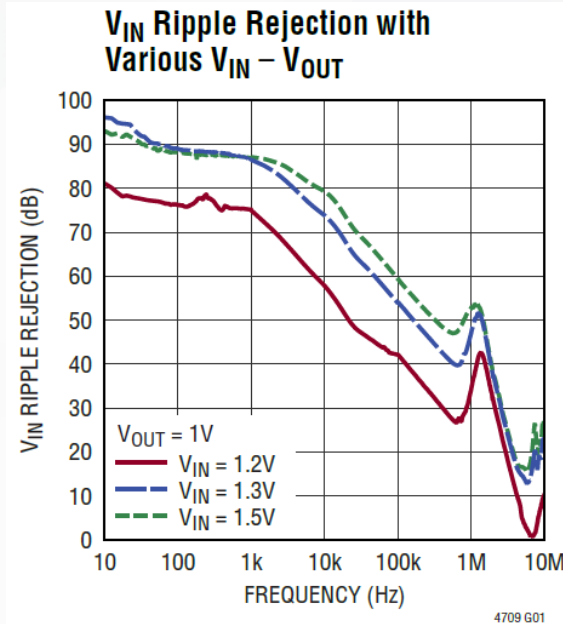
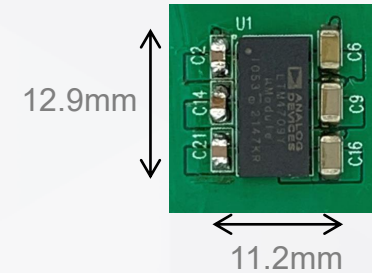
# LTM4709: Triple 3A, Ultralow Noise, High PSRR, $\mu$ Module Linear Regulator with Configurable Output Array

## FEATURES

- Linear Regulator  $\mu$ Module<sup>®</sup> with Triple 3A Output
- Input Voltage: 0.6V to 5.5V
- Configurable Output Voltage: 0.5V to 4.2V
- Ultralow RMS Noise:  $1.2\mu\text{V}_{\text{RMS}}$  (10Hz to 100kHz)
- High Frequency PSRR: 47dB at 1MHz
- Low Dropout Voltage: 45mV Typical at 3A
- Ultrafast Transient Response
- **50% Smaller Than Discrete Solutions**
- $\pm 1.5\%$  Output Voltage Regulation Over Line, Load, and Temperature
- $\pm 2.4\%$  Precision Current Monitor Accuracy at 3A
- Stable with Ceramic Output Capacitors (10 $\mu\text{F}$  Minimum)
- Parallel Multiple Devices for Higher Current
- PG Flag, UVLO, Overcurrent and Overtemperature Protection
- 150 $^{\circ}\text{C}$  Rated Available
- 6mm  $\times$  12mm  $\times$  1.92mm BGA Package



Solution size, **52% smaller**



Full load, no cooling



▶ Released



# LTM4709 Solution Size vs. Discrete Solution Size

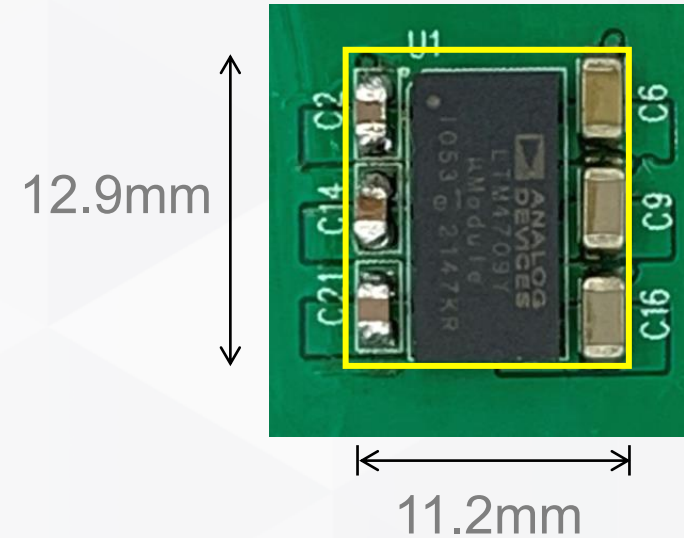
## ▶ Discrete Solution Size

( 302mm<sup>2</sup> )



## ▶ LTM4709 Solution Size

(145mm<sup>2</sup>)



LTM4709 reduces solution size by **52%**

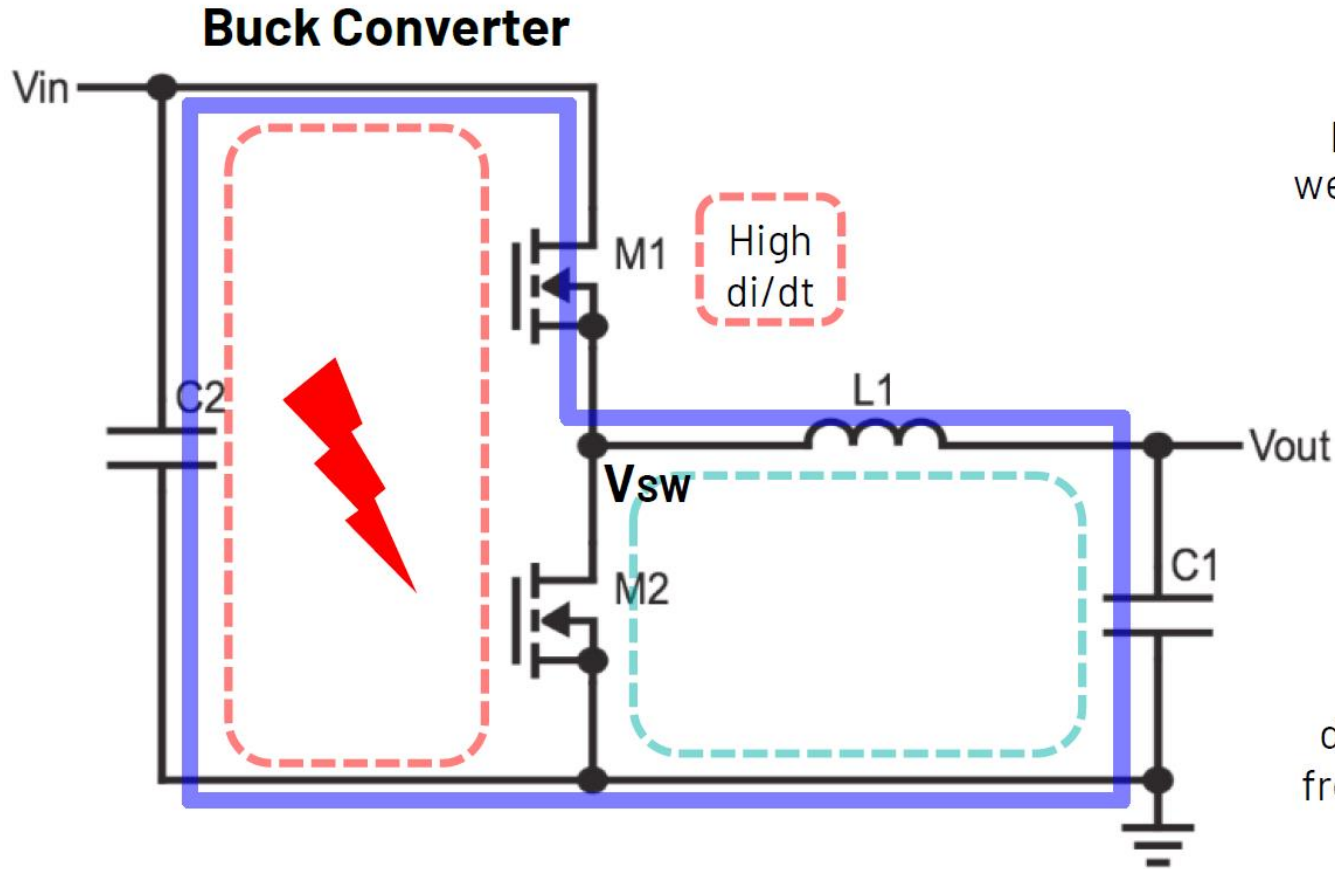


# Silent Switcher Technology

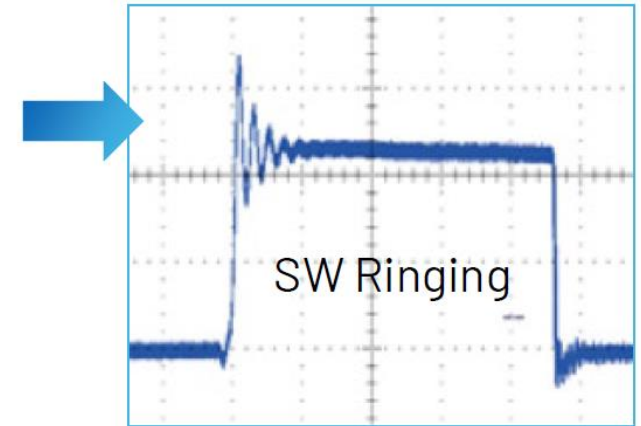
[analog.com](http://analog.com)



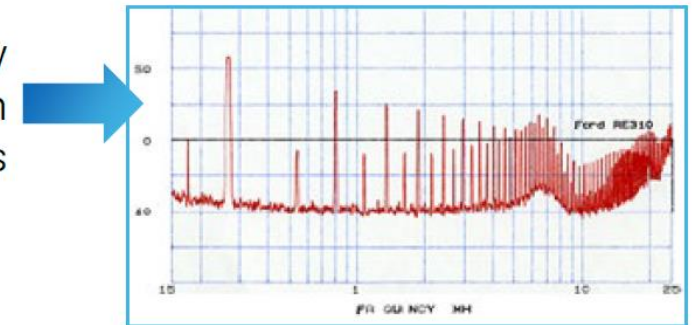
# Problem We Are Trying To Solve



In the time domain, we see ringing on the switch node



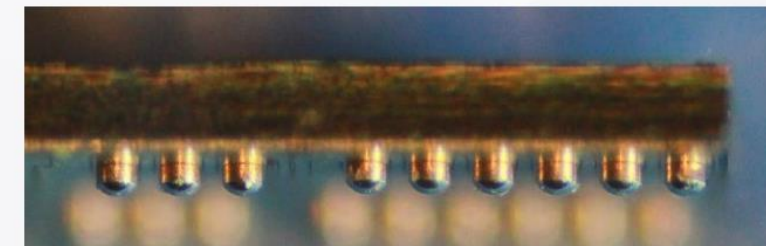
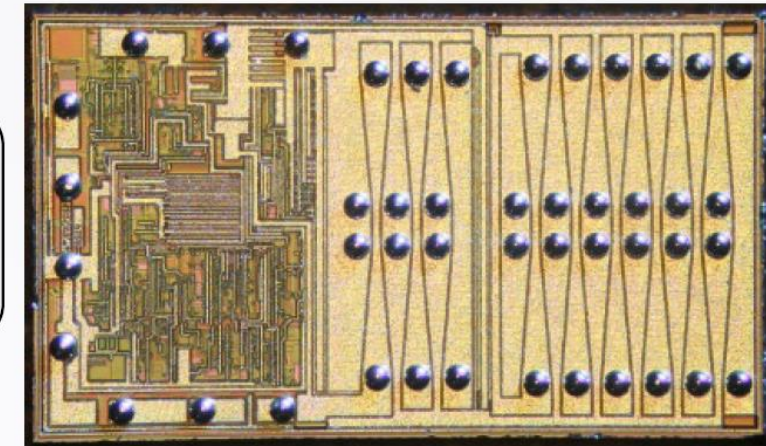
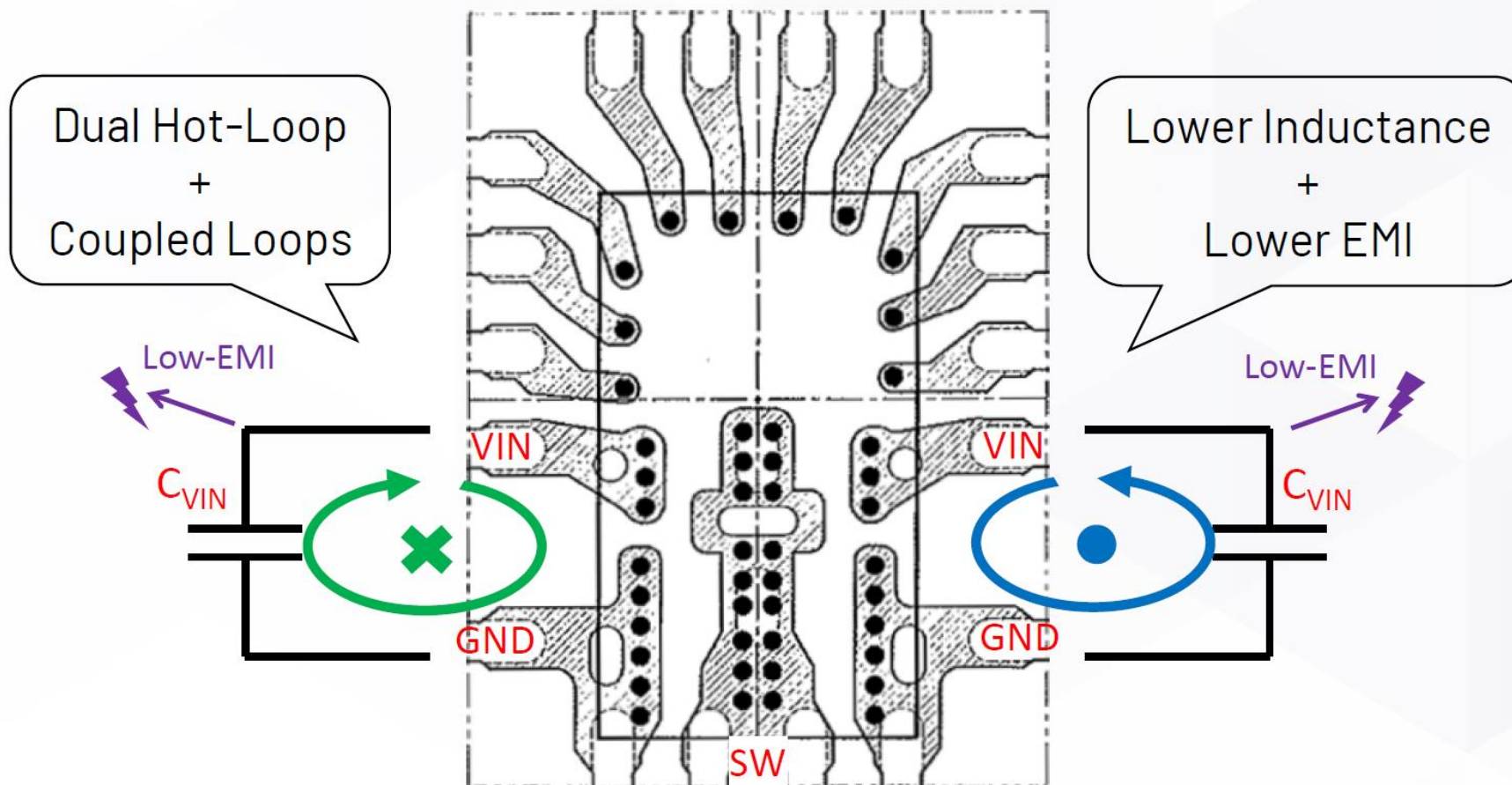
In the frequency domain, we see high frequency harmonics



- ▶ "Hot" loop: high  $di/dt$ , parasitic inductance
- ▶ Results in EM noise, SW ringing

# Silent Switcher

- Reduce parasitic inductance with copper pillar flip chip package
- Split current into two smaller, cancelling hot loops
- Enhanced switching driver for low power loss, faster switching
- high efficiency at high switching frequency
- lower EMI



Copper Pillars

# Silent Switcher Radiated EMI Results

**LT8610:** Wire-bonded in leaded package

**LT8640:** Silent Switcher 1: Magnetic cancellation + Copper Pillar Flip-Chip

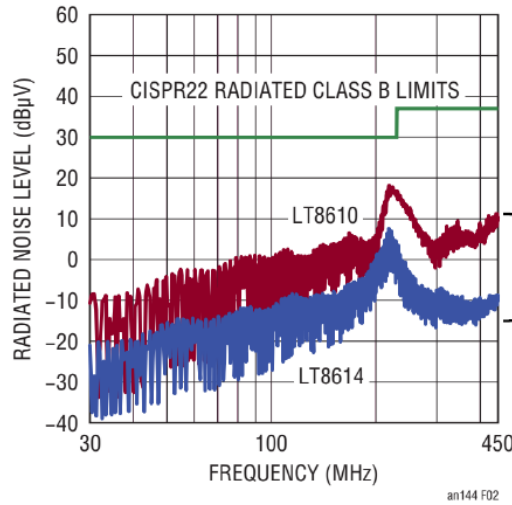
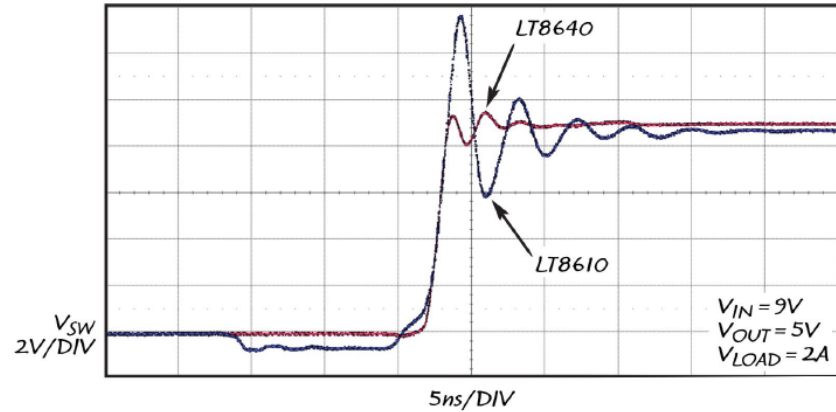
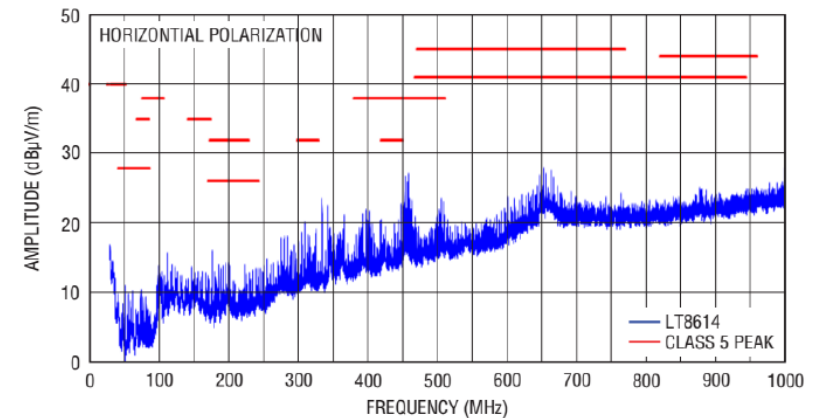
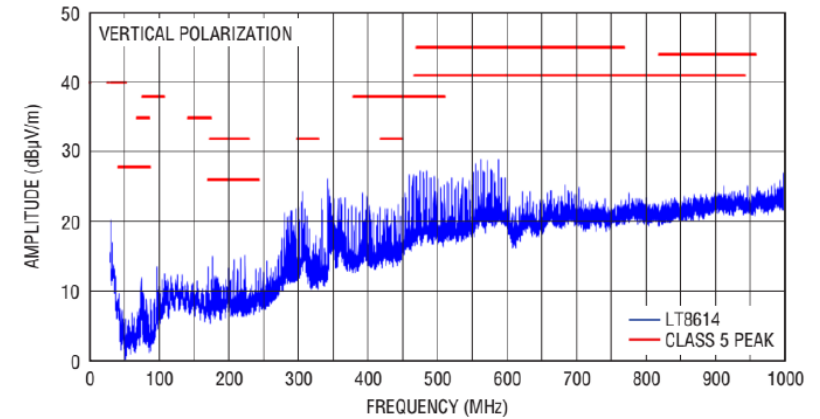


Figure 2. LT8610 and LT8614 700kHz 14V to 3.3V 2A Radiated EMI in GTEM Corrected for OATS

Silent Switcher: 10-20dB improvement!

Radiated EMI Performance (CISPR25 Radiated Emission Test with Class 5 Peak Limits)

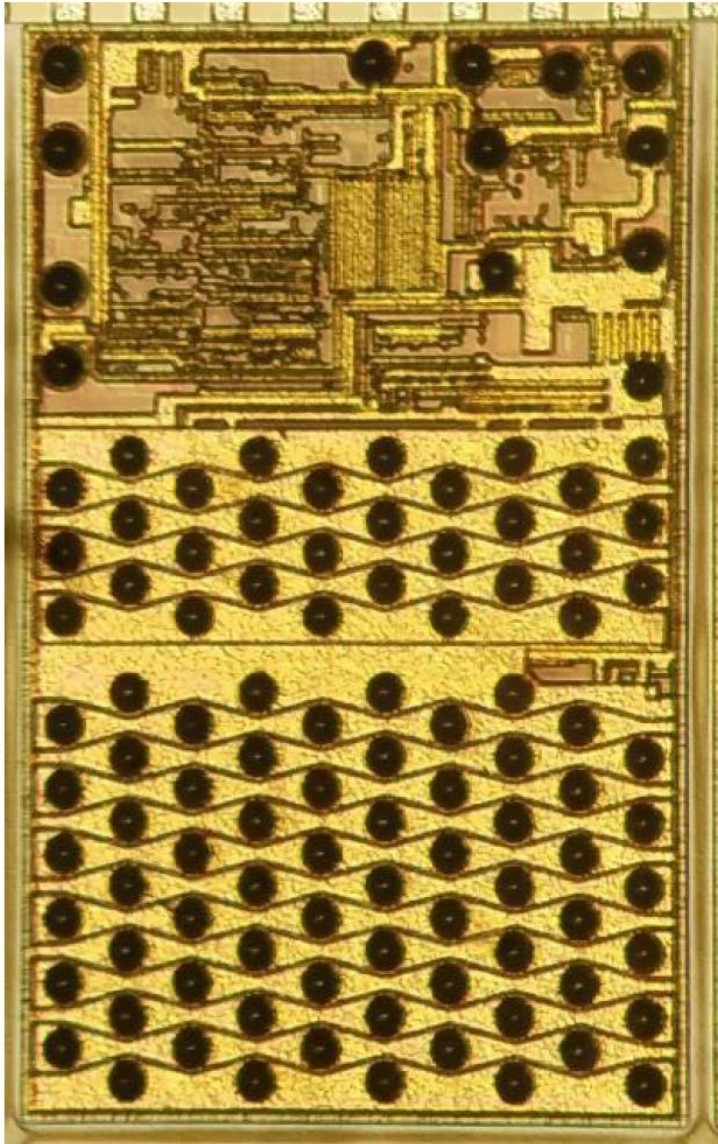


DC2019A DEMO BOARD (WITH EMI FILTER INSTALLED)  
14V<sub>IN</sub> TO 5V<sub>OUT</sub> AT 4A, f<sub>SW</sub> = 2MHz

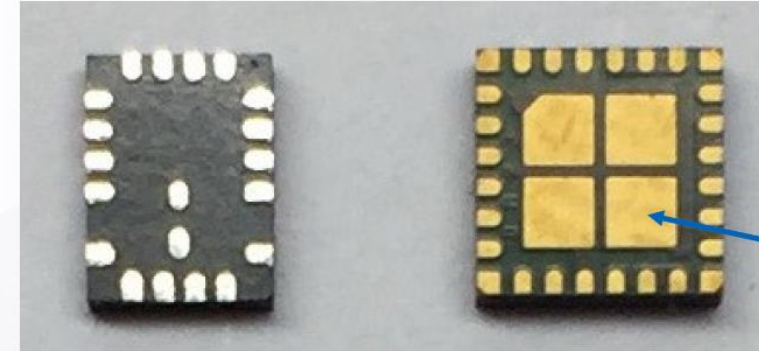
8014 G39

LT8614 passes the most stringent CISPR25 Class 5 Limits

# Silent Switcher 2: LQFN Package



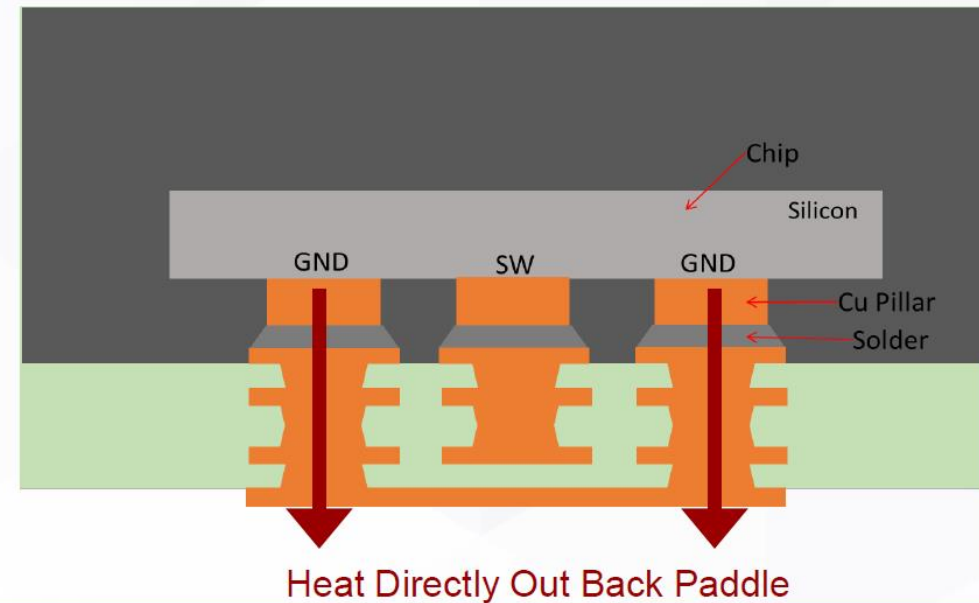
- ▶ More Copper Pillars
- ▶ Better Thermals
- ▶ Higher Efficiency



LT8640  
QFN Flip-Chip  
Silent Switcher 1

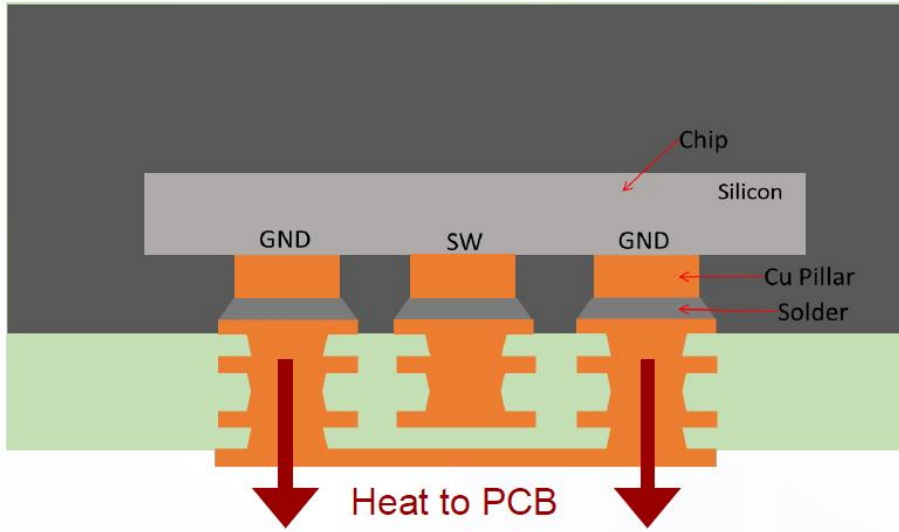
LT8640S  
LQFN Flip-Chip  
Silent Switcher 2

Large  
GND  
Exposed  
Pads!



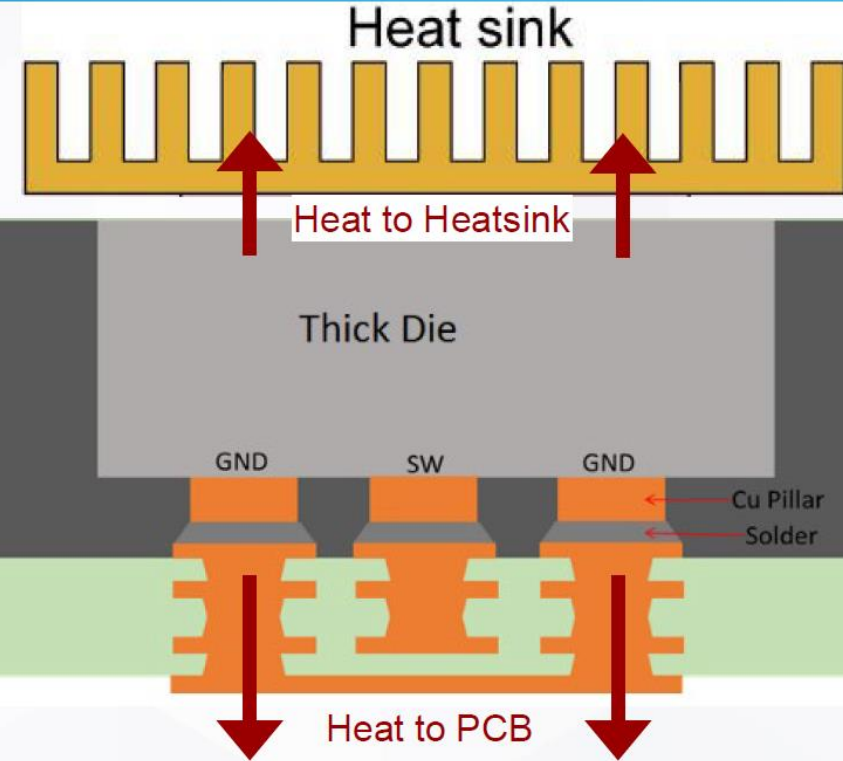
# Silent Switcher SP: Exposed die back for Heatsink Mount

## Silent Switcher 2 Cross-section



Maximum Dissipation ~2-3 Watt

LT8650S  
(no exposed die)



Customer attaches heatsink

## Silent Switcher SP

Exposed Die for Double Sided Cooling

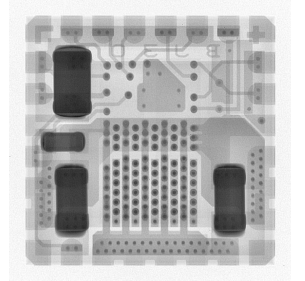
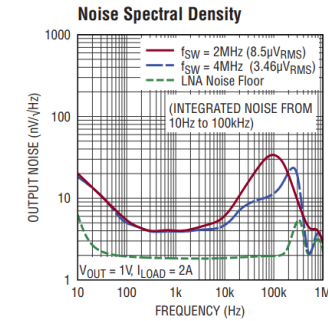
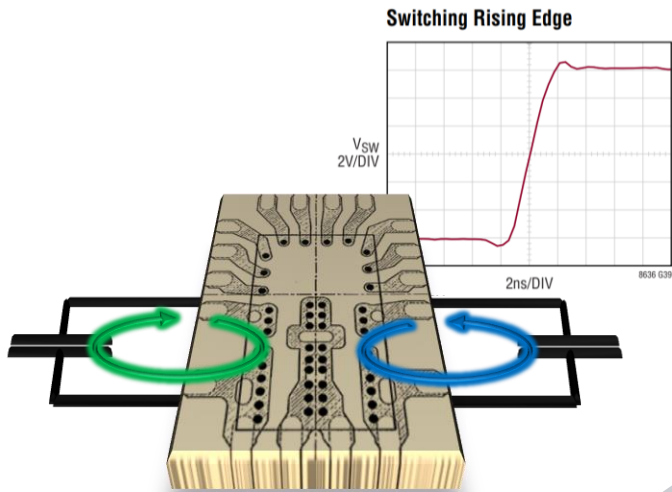
LT8650SP  
Exposed Die



\*P for exPosed

# Silent Switchers

- ▶ Ultralow EMI Emissions
- ▶ High Efficiency at High Switching Frequency
- ▶ Integrated Bypass Capacitors
- ▶ Eliminates PCB layout sensitivity
- ▶ **Ultralow LF Noise (0.1Hz to 100kHz)**
- ▶ **Ultrafast Transient Response**



Silent Switcher<sup>®1</sup>

Silent Switcher<sup>®2</sup>

Silent Switcher<sup>®3</sup>

## ► Why Silent Switcher 3?

- Improve LF (10Hz–100kHz) noise performance of Silent Switcher
- Low noise supplies increasing to current levels where LDOs become impractical

## ► What applications/markets are targeted with these parts?

- RF Power Supplies (PLLs, VCOs, Mixers, LNAs, PAs, etc)
- Low Noise Instrumentation
- High Speed/High Precision ADCs/DACs
- Medical Applications: Imaging, Diagnostics

## Best Low Noise LDO



ADI Power by Linear™

LT3045

20V, 500mA, Ultralow Noise,  
Ultrahigh PSRR Linear Regulator

### FEATURES

- **Ultralow RMS Noise: 0.8 $\mu$ V<sub>RMS</sub> (10Hz to 100kHz)**
- **Ultralow Spot Noise: 2nV/ $\sqrt$ Hz at 10kHz**
- Ultrahigh PSRR: 76dB at 1MHz
- Output Current: 500mA
- Wide Input Voltage Range: 1.8V to 20V
- Single Capacitor Improves Noise and PSRR
- 100 $\mu$ A SET Pin Current:  $\pm$ 1% Initial Accuracy
- Single Resistor Programs Output Voltage
- High Bandwidth: 1MHz

### DESCRIPTION

The **LT<sup>®</sup>3045** is a high performance low dropout linear regulator featuring LTC's ultralow noise and ultrahigh PSRR architecture for powering noise sensitive applications. Designed as a precision current reference followed by a high performance voltage buffer, the LT3045 can be easily paralleled to further reduce noise, increase output current and spread heat on the PCB.

The device supplies 500mA at a typical 260mV dropout voltage. Operating quiescent current is nominally 2.2mA

## Silent Switcher 3



ADI Power by Linear™

LT8625S

18V/8A Step-Down Silent Switcher 3 with  
Ultralow Noise Reference

### FEATURES

- **Silent Switcher<sup>®</sup>3 Architecture**
- **Ultralow RMS Noise (10Hz to 100kHz): 4 $\mu$ V<sub>RMS</sub>**
- **Ultralow Spot Noise: 4nV/ $\sqrt$ Hz at 10kHz**
- Ultralow EMI Emissions on Any PCB
- Internal Bypass Capacitors Reduce Radiated EMI
- High Efficiency at High Frequency
- Ultrafast Transient Response with High Gain Error Amplifier
- Input Voltage Range: 2.7V to 18V

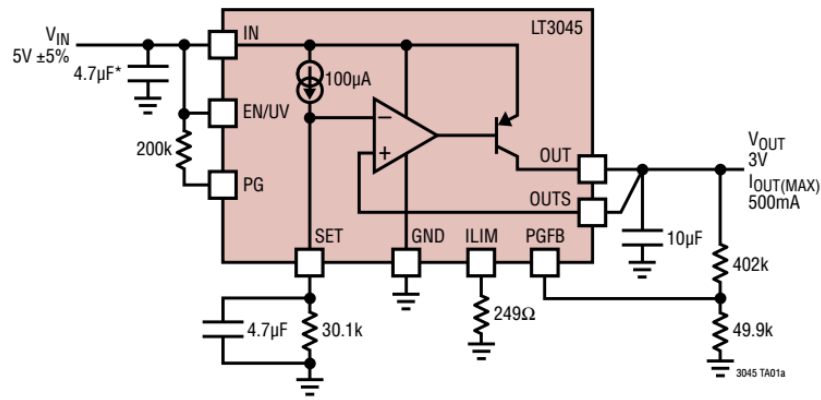
### DESCRIPTION

The **LT<sup>®</sup>8625S** synchronous step-down regulator features third-generation Silent Switcher technology which is uniquely designed to combine an ultralow noise reference with Silent Switcher architecture in order to achieve both high efficiency and excellent wideband noise performance.

The innovative ultralow noise architecture provides exceptional low frequency (0.1Hz to 100kHz) output noise performance in a switching regulator. The output voltage can

# Silent Switcher 3 Intro – How do we achieve this?

Ultralow LF Noise  
Current Reference  
Error Amplifier

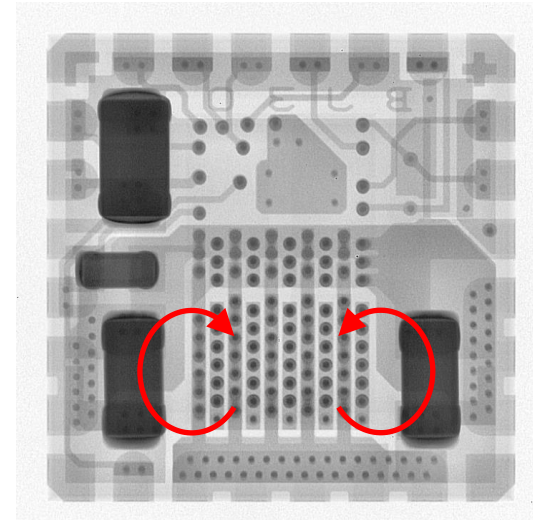


LT3045  
Ultralow Noise LDO

ADI Process:  
BJTs  
NLDMOS



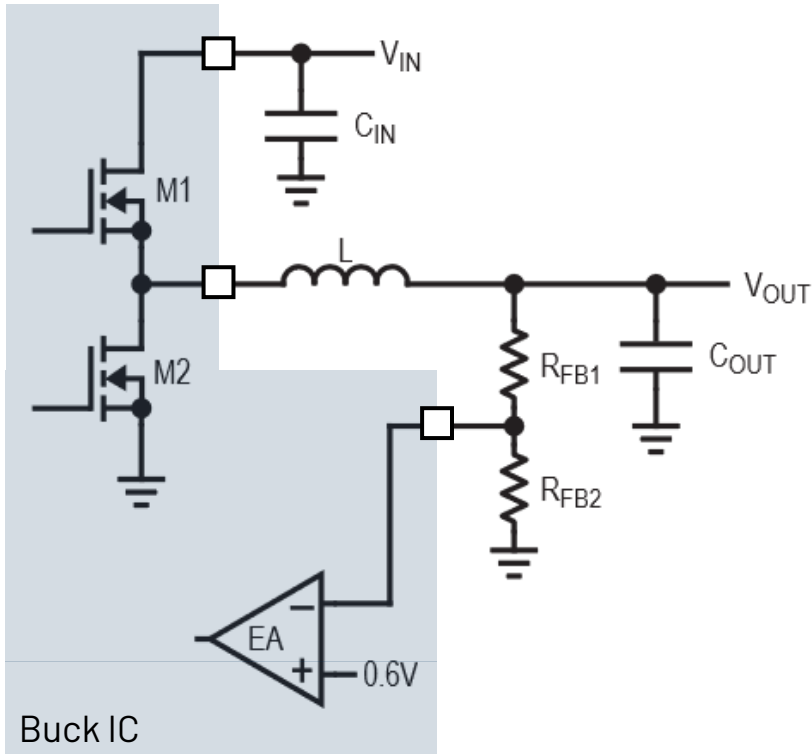
Silent Switcher Powertrain  
+ Buck Control



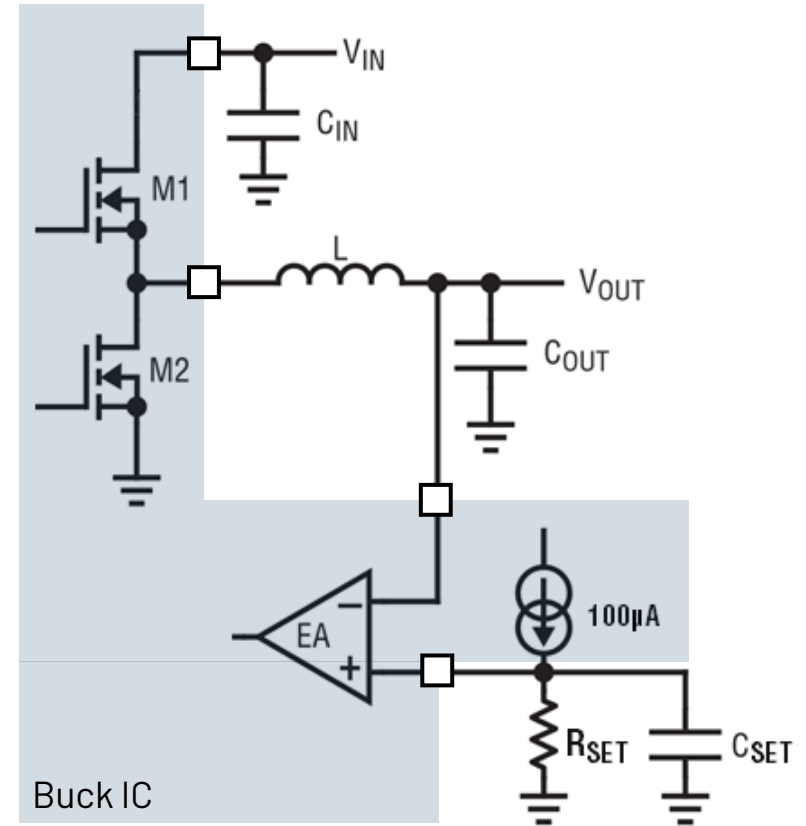
LT864X  
Silent Switcher Buck

Note: SS3 is NOT a switcher+LDO part! Switcher only!

# Voltage Reference vs Current Reference

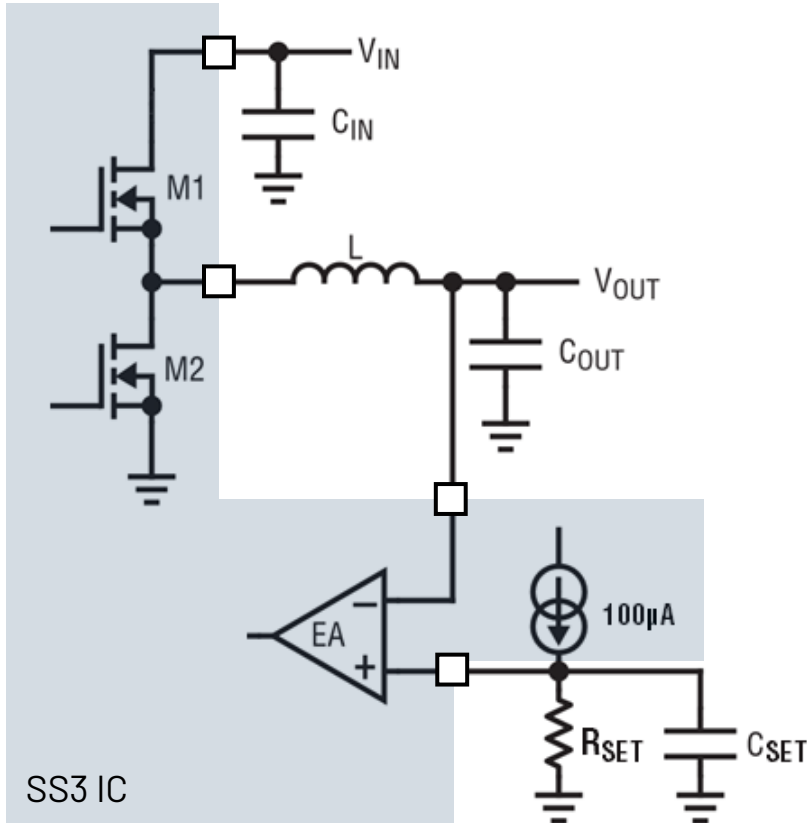


Conventional Voltage Reference



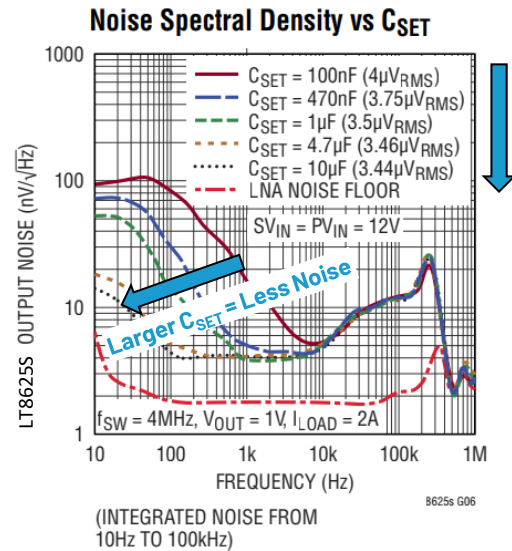
Current Reference

# SS3: Benefits of a Current Reference Architecture



SS3 IC

- ▶ Unity gain feedback! Reference =  $V_{OUT}$ 
  - Noise is independent of  $V_{OUT}$ ; No FB divider factor to gain up ref noise to output
  - No added resistor noise from  $R_{FB}$  divider itself
- ▶ External (large)  $C_{SET}$  capacitor on reference filters LF noise
- ▶ Single resistor programs  $V_{OUT}$
- ▶  $V_{OUT}$  can be set down to 0V
- ▶ **Easy Differential Remote Sense**



(12) **United States Patent**  
**Dobkin**

(10) **Patent No.:** US 8,085,029 B2  
(45) **Date of Patent:** Dec. 27, 2011

(54) **BANDGAP VOLTAGE AND CURRENT REFERENCE**

FOREIGN PATENT DOCUMENTS  
EP 0 687 967 A1 12/1995  
JP 58-172722 10/1983

(75) Inventor: **Robert C. Dobkin**, Monte Sereno, CA (US)

(73) Assignee: **Linear Technology Corporation**, Milpitas, CA (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 369 days.

(21) Appl. No.: **11/731,279**

(22) Filed: **Mar. 30, 2007**

(65) **Prior Publication Data**  
US 2008/0238400 A1 Oct. 2, 2008

(51) **Int. Cl.**  
*G05F 3/16* (2006.01)  
*G05F 3/20* (2006.01)

(52) **U.S. Cl.** ..... **323/314; 323/315**

(58) **Field of Classification Search** ..... 323/313, 323/273, 311, 312, 314, 315, 316, 907; 327/539  
See application file for complete search history.

(56) **References Cited**

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4,656,415 A \* 4/1987 Draxelmayr ..... 323/314  
5,629,612 A 5/1997 Schaffer

OTHER PUBLICATIONS

Avoine, C., et al. *Second-order compensated bandgap reference with convex correction*, Electronics Letter, vol. 41, No. 5, Mar. 3, 2005, 2 pgs.  
Wildar, Robert J., *Low Voltage Techniques*, IEEE Journal of Solid-State Circuits, vol. SC-13, No. 6, Dec. 1978, pp. 838-846.  
Gunawan, Made et al., *A Curvature-Corrected Low-Voltage Bandgap Reference*, IEEE Journal of Solid-State Circuits, vol. 28, No. 6, Jun. 1993, pp. 667-670.  
*The Best of Bob Pease: The Design of Band-Gap Reference Circuits: Trials and Tribulations*, Sep. 2006, 7 pgs.  
LM10 Operational Amplifier and Voltage Reference, National Semiconductor, Aug. 2000, pp. 1-25.  
International Preliminary Report on Patentability issued in corresponding International Application No. PCT/US2007/018298, mailed on Apr. 14, 2008.  
Piero Malcovati, et al., *Curvature-Compensated BiCMOS Bandgap with 1-V Supply Voltage*, IEEE Journal of Solid-State Circuits, vol. 36, No. 7, Jul. 2001, pp. 1076-1081.

\* cited by examiner

*Primary Examiner* — Harry Behm  
*Assistant Examiner* — Matthew Grubb  
(74) *Attorney, Agent, or Firm* — McDermott Will & Emery LLP

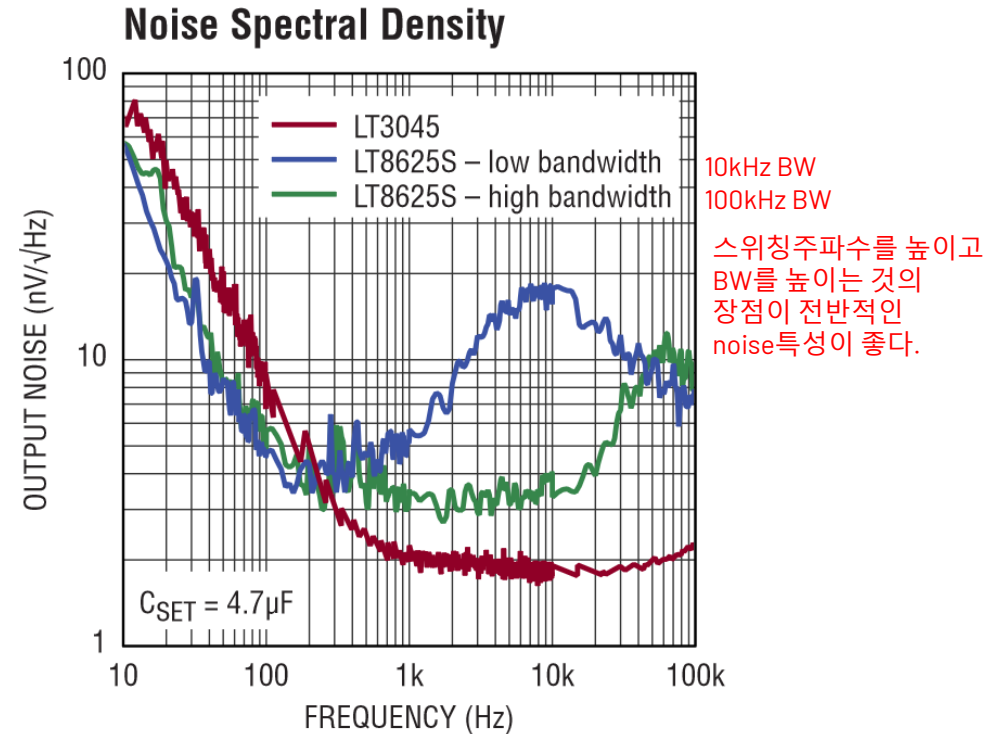
(57) **ABSTRACT**

Circuits and methods that improve the performance of reference circuits are provided. A reference generator circuit

# LT8625S SS3 Low Frequency Noise Performance

## Integrated Noise from 10Hz-100kHz

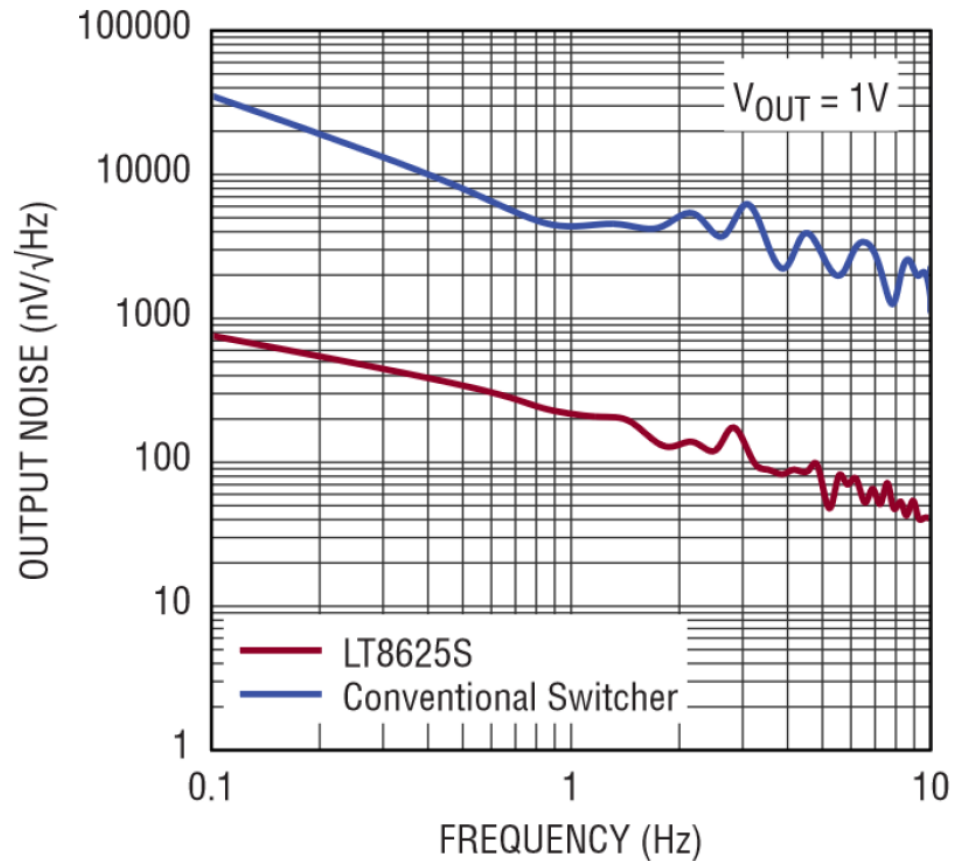
LT3045	$0.8\mu\text{V}_{\text{RMS}}$
Li-ion battery	$2.7\mu\text{V}_{\text{RMS}}$
<b>LT8625S (high bandwidth)</b>	<b><math>2.7\mu\text{V}_{\text{RMS}}</math></b>
LT8625S (low bandwidth)	$3.7\mu\text{V}_{\text{RMS}}$
Low noise LDO (from Competitor T)	$4.4\mu\text{V}_{\text{RMS}}$
Typical LDOs	$\sim 20\text{-}100\mu\text{V}_{\text{RMS}}$
LT8643S (SS2 in unity gain fb)	$123\mu\text{V}_{\text{RMS}}$



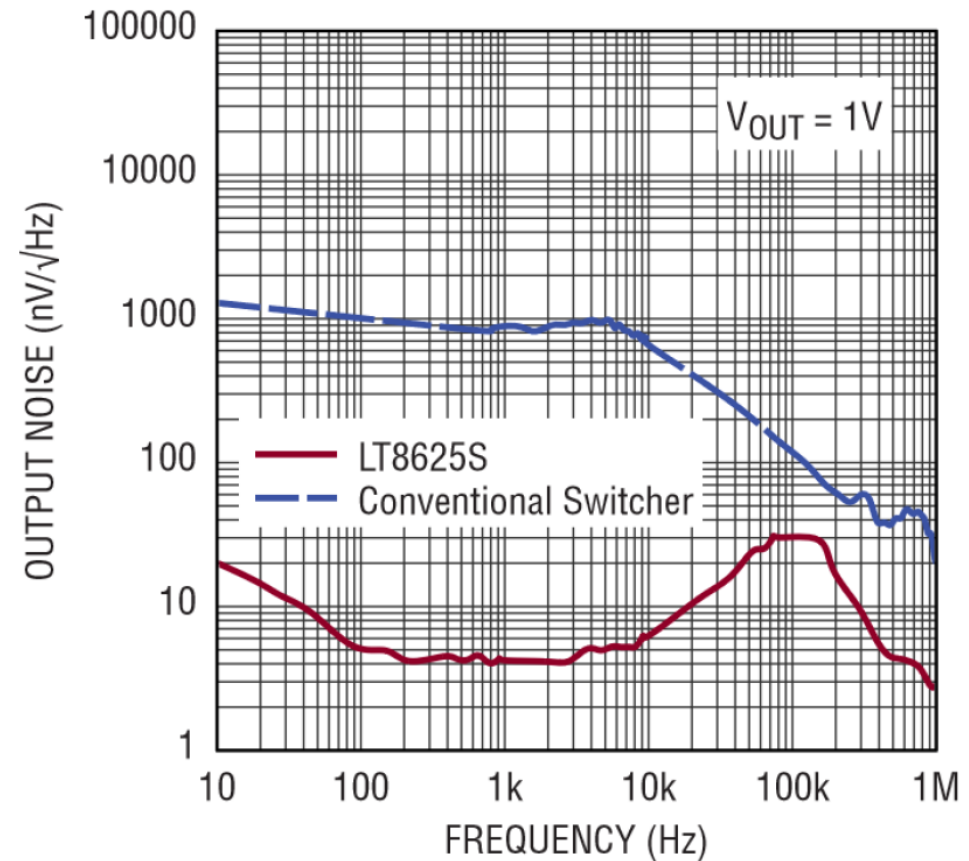
► Note: LT3045 is the lowest noise LDO on the market!

# Noise Spectral Density LT8625S vs. Conventional Switcher

### Noise Spectral Density 0.1Hz to 10Hz



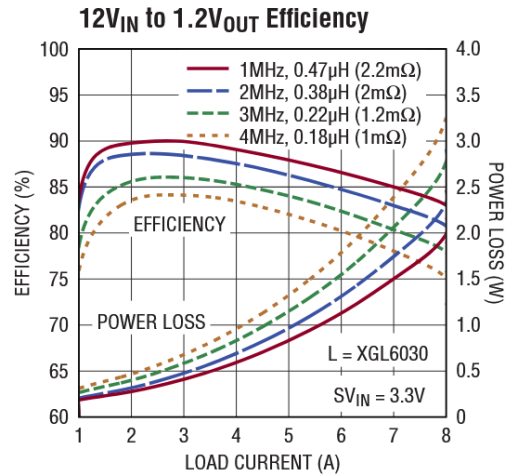
### Noise Spectral Density 10Hz to 100kHz



# Silent Switcher 3 Feature Highlights

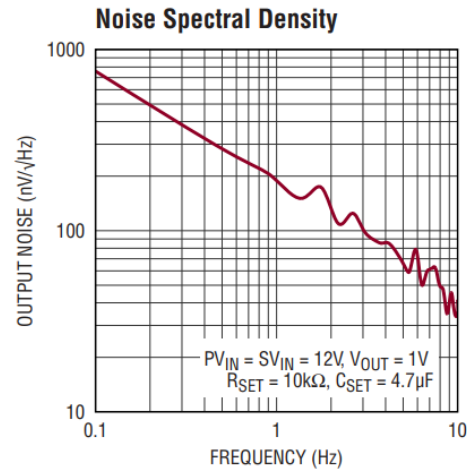
## High Efficiency at High $f_{sw}$ Ultralow EMI Emissions

Next Gen Power FETs  
Silent Switcher Powertrain



## Ultralow LF Noise

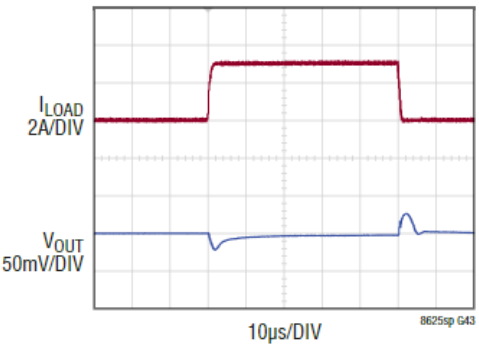
RMS Noise (10Hz to 100kHz): 3.5 $\mu$ V<sub>RMS</sub>  
Spot Noise: 4nV/ $\sqrt$ Hz at 10kHz



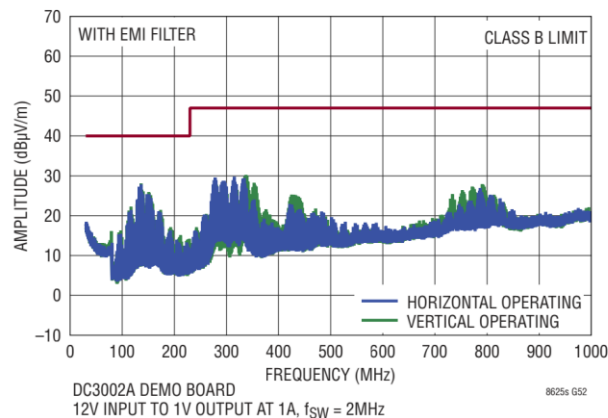
## Ultrafast Transient Response

High Gain Error Amplifier  
Unity Gain Feedback

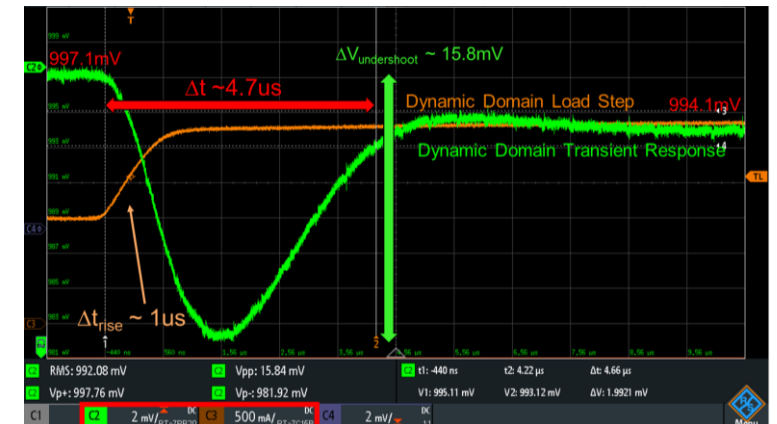
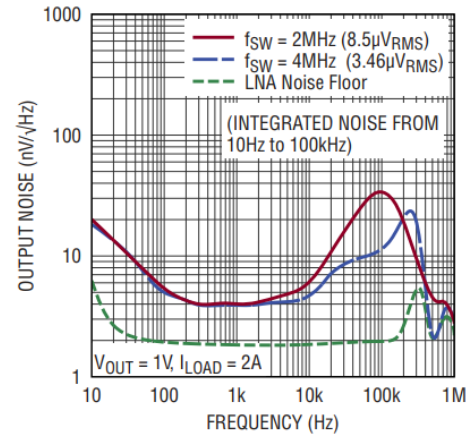
### Transient Response: Load Current Stepped from 2A to 5A



## Radiated EMI Performance (CISPR32 Radiated Emission Test with Class B Limits)



## Noise Spectral Density





# Silent Switcher uModule

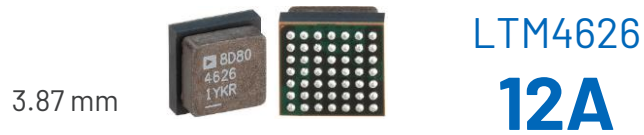
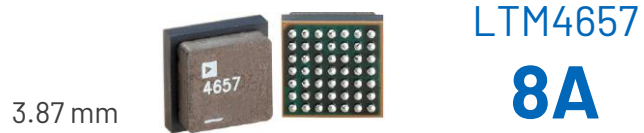
[analog.com](http://analog.com)



# Silent Switcher Versions of the LTM4657, LTM4626, LTM4638

## LTM4657, LTM4626, LTM4638

6.25 x 6.25mm, pin-compatible



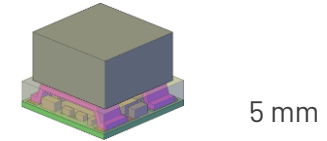
## Silent Switcher: LTM4702, LTM4703, LTM4707

6.25 x 6.25mm, pin-compatible

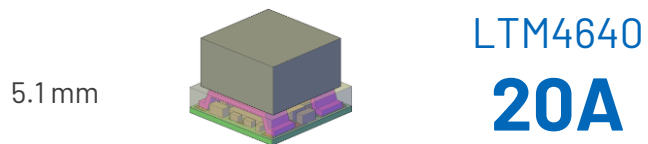
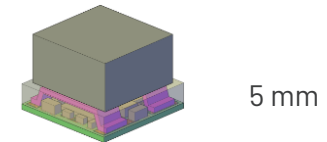
LTM4702  
**8A**



LTM4703  
**12A**



LTM4707  
**16A**



No plan for Silent Switcher yet

# LTM4702, LTM4703 and LTM4707 Difference

	LTM4702	LTM4703	LTM4707
	Silent Switcher Architecture		
Vin	3V to 16V		
Vout	0.3V to 5.7V	0.3V to 6V	
Iout	8A	12A	16A
Package Size (mm)	6.25 x 6.25 x 5.07 BGA		
Release Status	Released	Sept 2024	Nov 2024
Samples and Datasheet	Released	Please contact $\mu$ Module Marketing Team	
	Pin-Compatible		

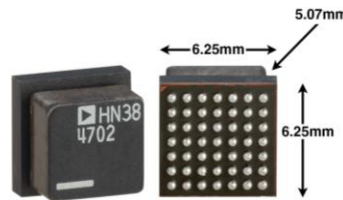
# LTM4702: 16V<sub>IN</sub>, 8A Ultralow Noise Silent Switcher $\mu$ Module Regulator

## FEATURES

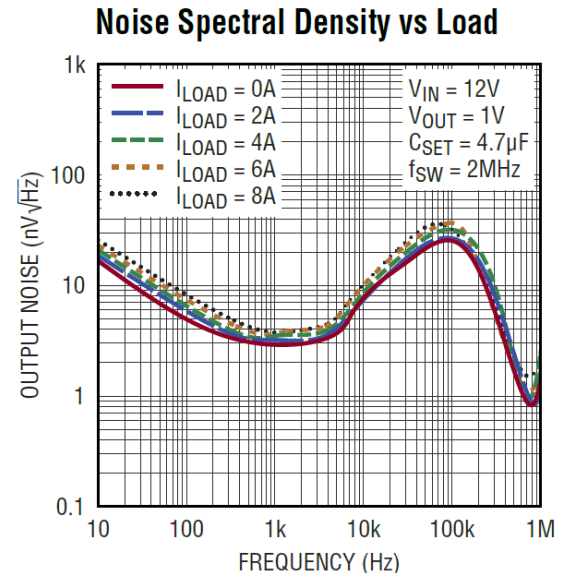
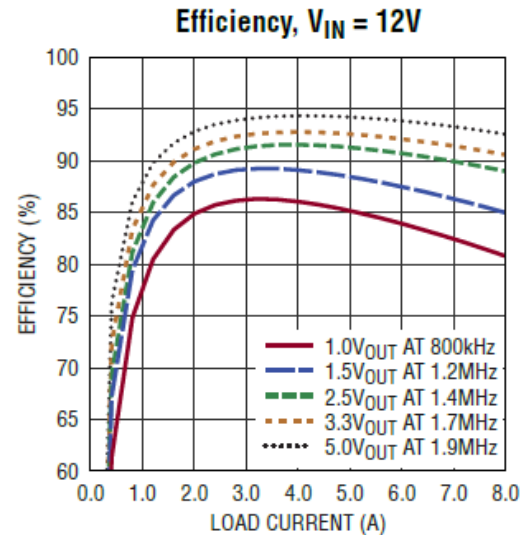
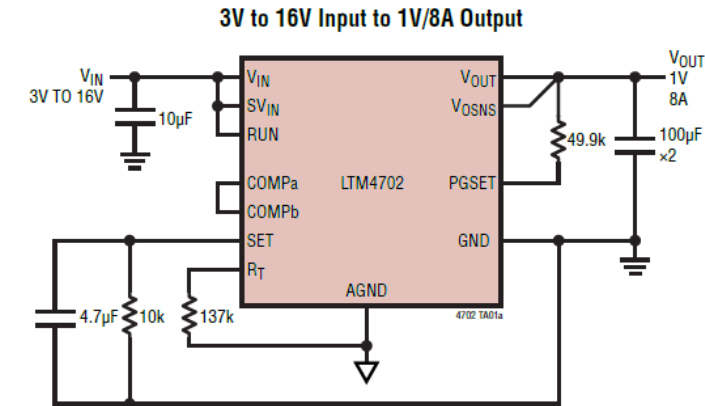
- Complete Solution in <math> < 1\text{cm}^2 </math> (Single-Sided PCB) or <math> < 0.5\text{cm}^2 </math> (Dual-Sided PCB)
- Low Noise Silent Switcher Architecture
  - Ultralow EMI Emissions
  - Ultralow RMS Noise (10Hz to 100kHz): <math> 8\mu\text{V}\_{\text{RMS}} </math>
- $\pm 1.5\%$  Maximum Total DC Output Voltage Error Over Line, Load, and Temperature
- Input Voltage Range: 3V to 16V
- Output Voltage Range: 0.3V to 5.7V
- 8A Maximum Continuous Output Current
- Adjustable and Synchronizable: 300kHz to 3MHz
- Current Mode Control, Fast Transient Response
- Forced Continuous Mode Capability
- Multiphase Parallel with Current Sharing
- Programmable Power Good
- 6.25mm  $\times$  6.25mm  $\times$  5.07mm BGA Package

## APPLICATIONS

- Telecom, Networking, and Industrial Equipment
- RF Power Supplies: PLLs, VCOs, Mixers, LNAs, PAs
- Low Noise Instrumentation
- High Speed/High Precision Data Converters



## TYPICAL APPLICATION

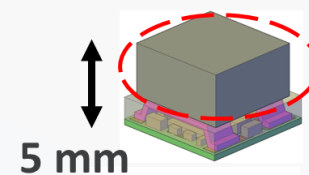


## FEATURES

- Complete Solution in <math><1\text{cm}^2</math> (Single-Sided PCB) or <math>0.5\text{cm}^2</math> (Dual-Sided PCB)
- Low Noise Silent Switcher<sup>®</sup>3 Architecture
  - Ultralow EMI Emissions on Any PCB
  - Ultralow RMS Noise (10Hz to 100kHz): 4uVrms
  - Ultralow Spot Noise: 4nV/ $\sqrt{\text{Hz}}$  at 10kHz
- Input Voltage Range: 2.7V to 18V
- Output Voltage Range: 0V to 6V
- 16A Maximum Continuous Output Current
- Fast Minimum Switch On-Time: 15ns
- Precision Current Reference: 100 $\mu$ A  $\pm$ 0.8% Over Temperature
- Fast Start-Up Capability
- Wide Frequency Range: 300kHz to 4MHz
- Multiphase Parallel with Current Sharing
- Programmable Power Good
- Wide Temperature Range: -40°C to 150°C
- 6.25mm  $\times$  6.25mm  $\times$  5.07mm BGA Package

## APPLICATIONS

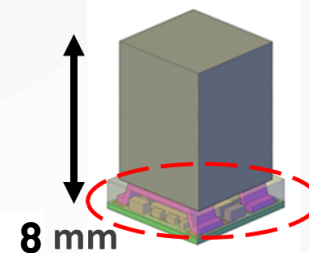
- RF Power Supplies: PLLs, VCOs, Mixers, LNAs, PAs
- Low Noise Instrumentation
- High Speed/High Precision Data Converters



LTM4702

**8A**

150C Operation  
Based on LT8625

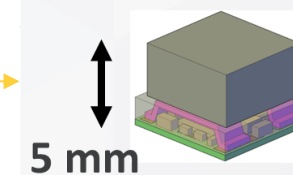


LTM4707

**16A**

150C Operation  
Based on LT8627

Higher current, same inductor series, different IC



LTM4703

**12A**

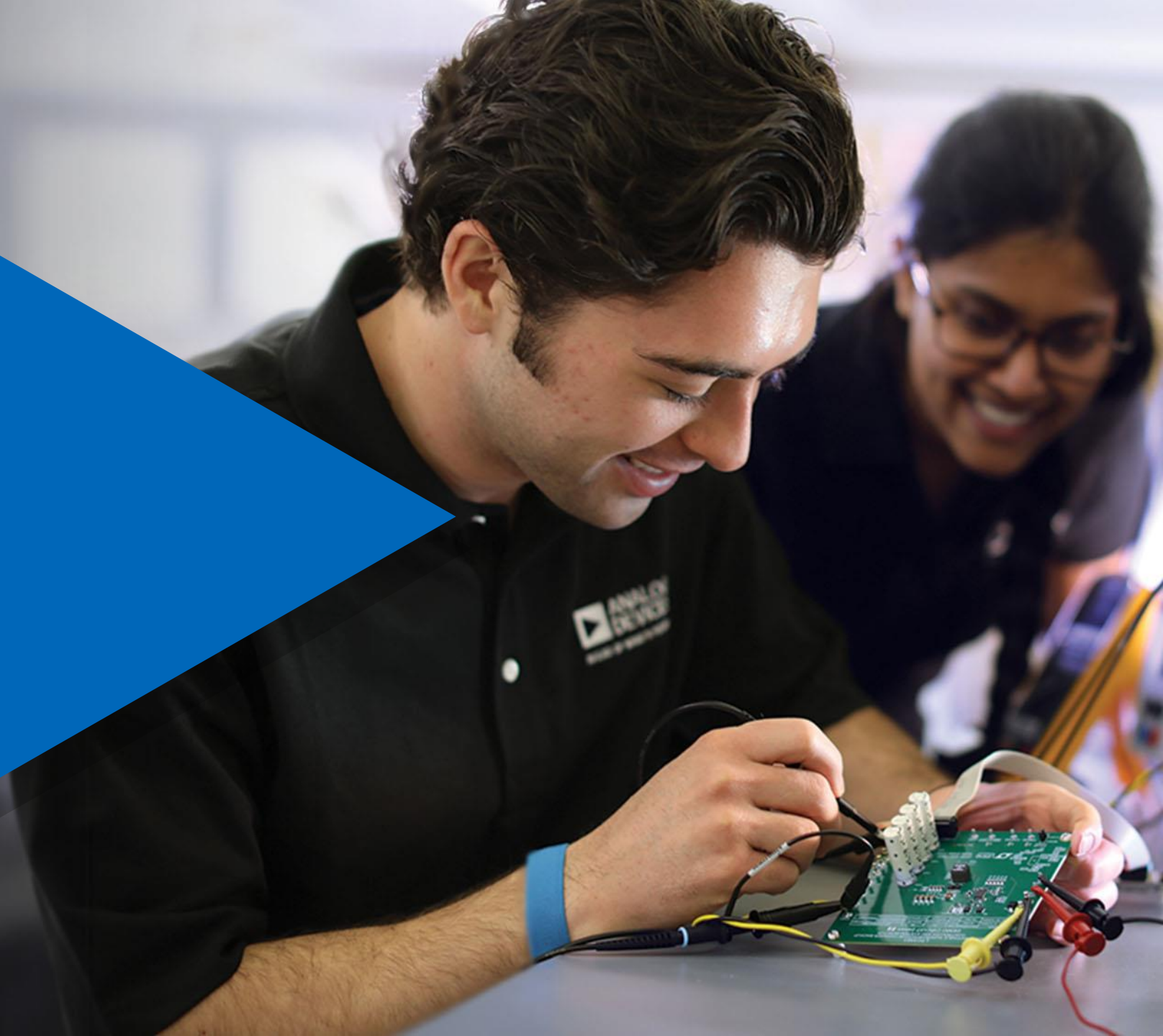
150C Operation  
Based on LT8627

Higher current, different inductor, same IC



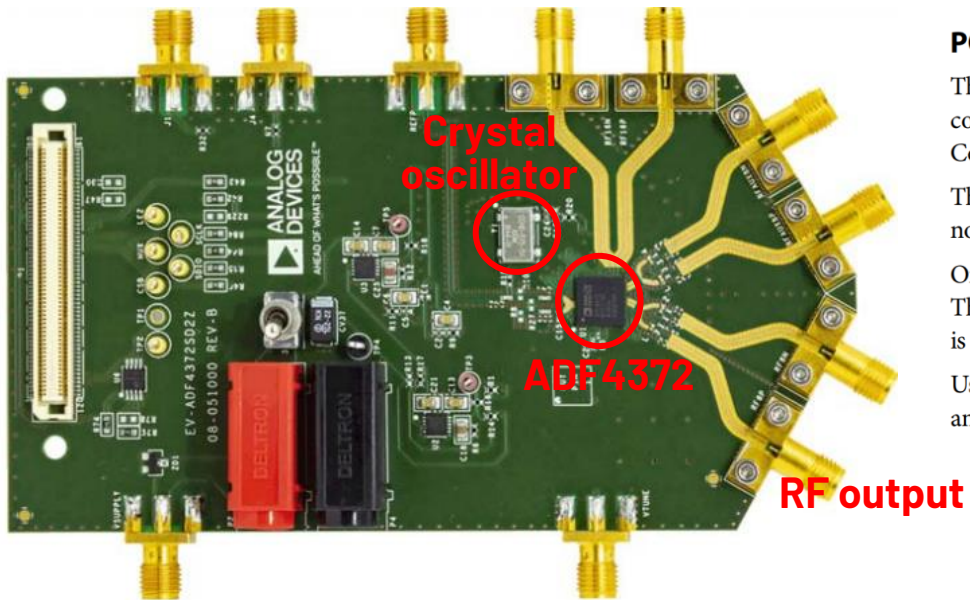
# Case Study: PLL ADF4372

[analog.com](http://analog.com)



# Phase Noise Measurement

- ▶ Phase noise: indication of short-time frequency stability of RF signals in frequency domain
- ▶ Test setup based on ADF4372 demo board from ADI
  - ❑ ADF4372: PLL frequency synthesizer rated at 5 GHz
  - ❑ **5 V provided by Silent Switcher 3 (LT8625SP)**
  - ❑ 3.3 V provided by onboard ultra-low-noise LDO



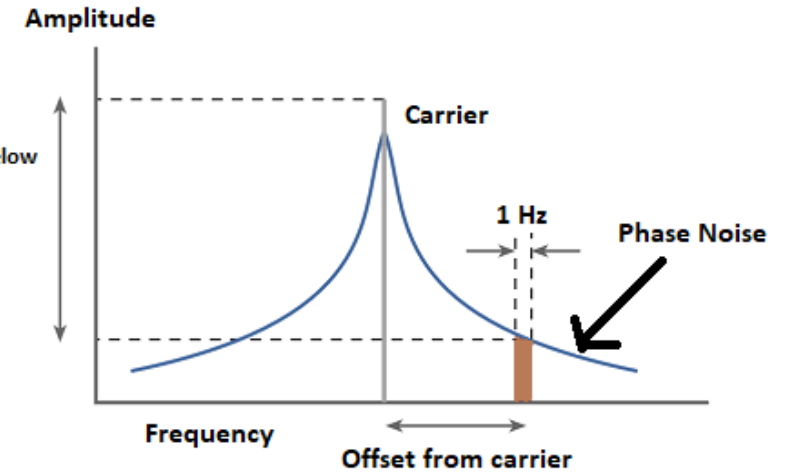
## POWER SUPPLIES

The EV-ADF4372SD2Z board is powered by a 6 V power supply connected to the VSUPPLY SMA, or the red banana plug, P2. Connect GND to the black banana plug, P4.

The power supply circuitry has two **LT3045**, high performance, low noise, and low dropout (LDO) regulators.

One **LT3045** is used to generate 5 V to drive the VCO supply pins. The remaining supplies are powered from the other **LT3045**, which is set to 3.3 V voltage.

Use Switch S1 to switch the 6 V to the EV-ADF4372SD2Z on and off.

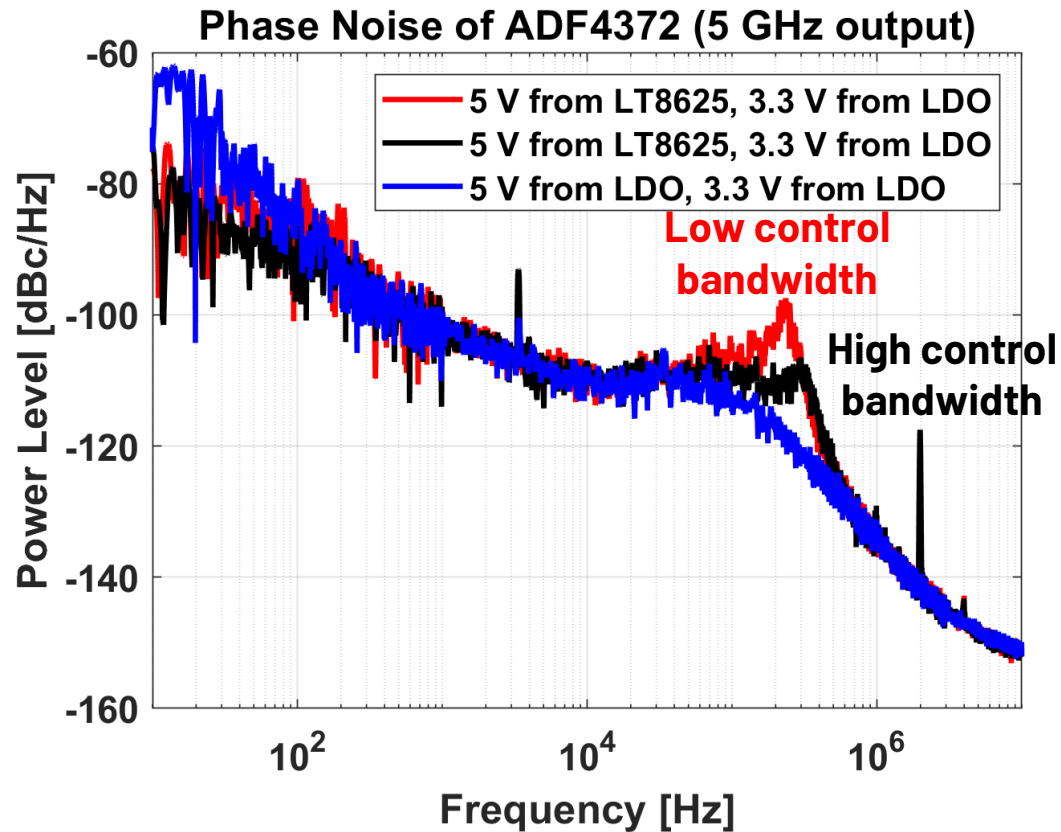


$$\text{Phase noise} = 10 \cdot \log \left[ \frac{\text{Noise Power Density}}{\text{Carrier Power}} \right]$$

- ❑ Phase noise: in dBc/Hz
- ❑ Noise power density: in W/Hz or dBm/Hz
- ❑ Carrier power: in W or dBm

## ► Impact of control bandwidth of Silent Switcher 3

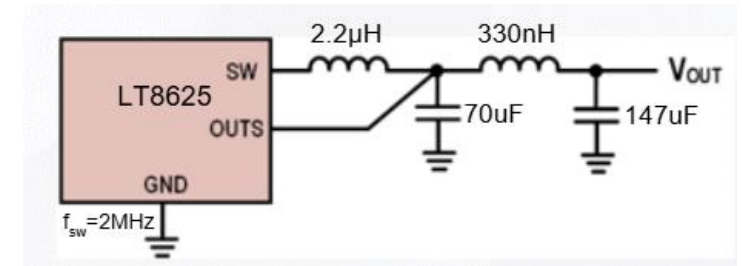
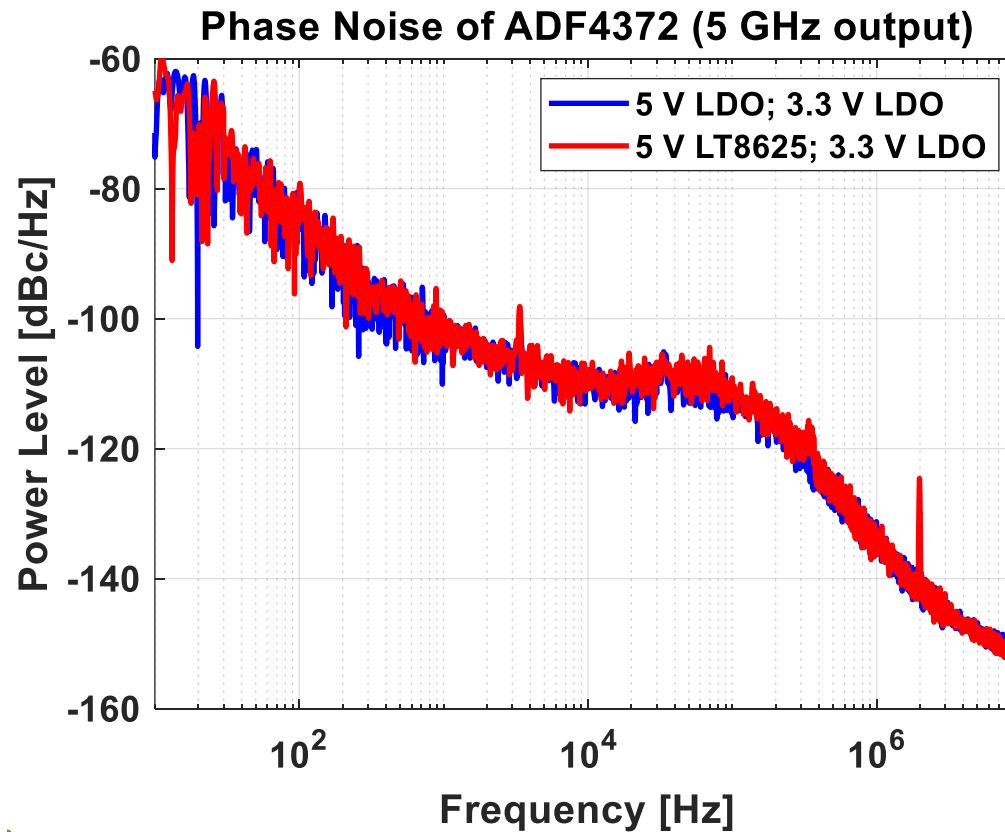
- Phase noise from 20 kHz to 500 kHz can be improved by increasing bandwidth of LT8625SP



Baseline: 5 V and 3.3 V from ultra-low noise LDO (LT3045)

# Phase Noise Test: 5 V from LT8625SP; 3.3 V from LDO

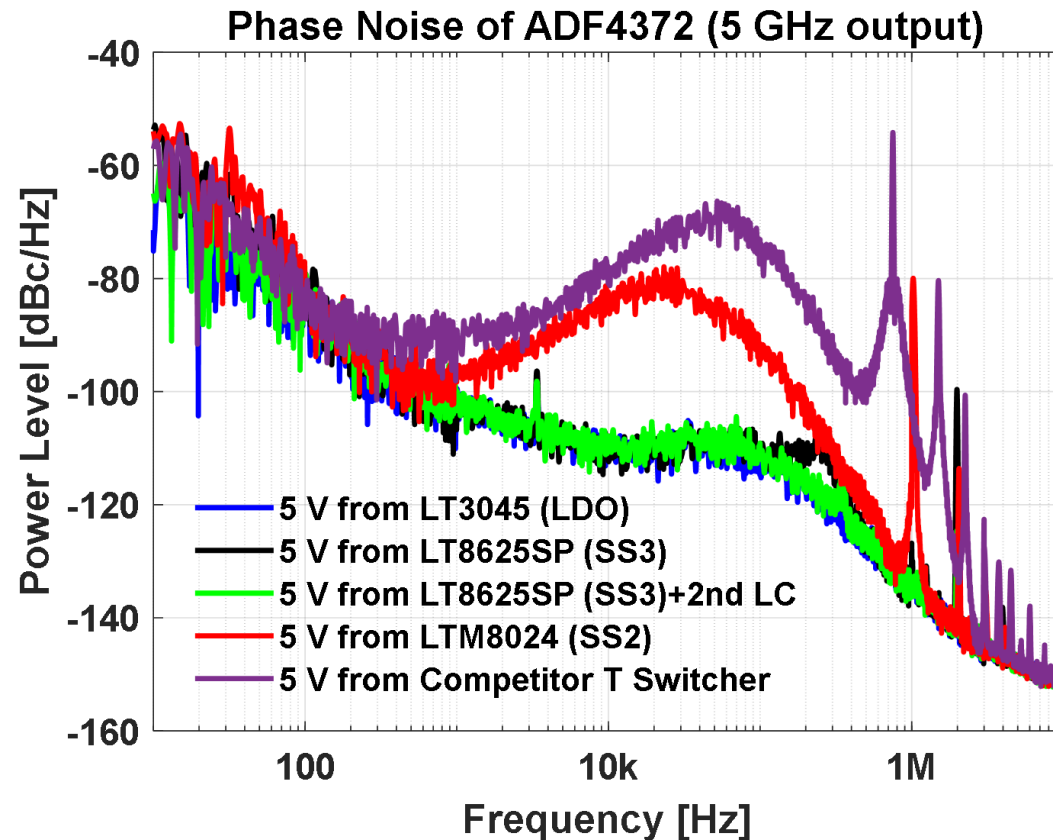
- ▶ Comparison with baseline (both 5 V and 3.3 V from LDO) after adding 2<sup>nd</sup> stage LC filter (330 nH inductor)



Baseline: 5 V and 3.3 V from ultra-low noise LDO (LT3045)

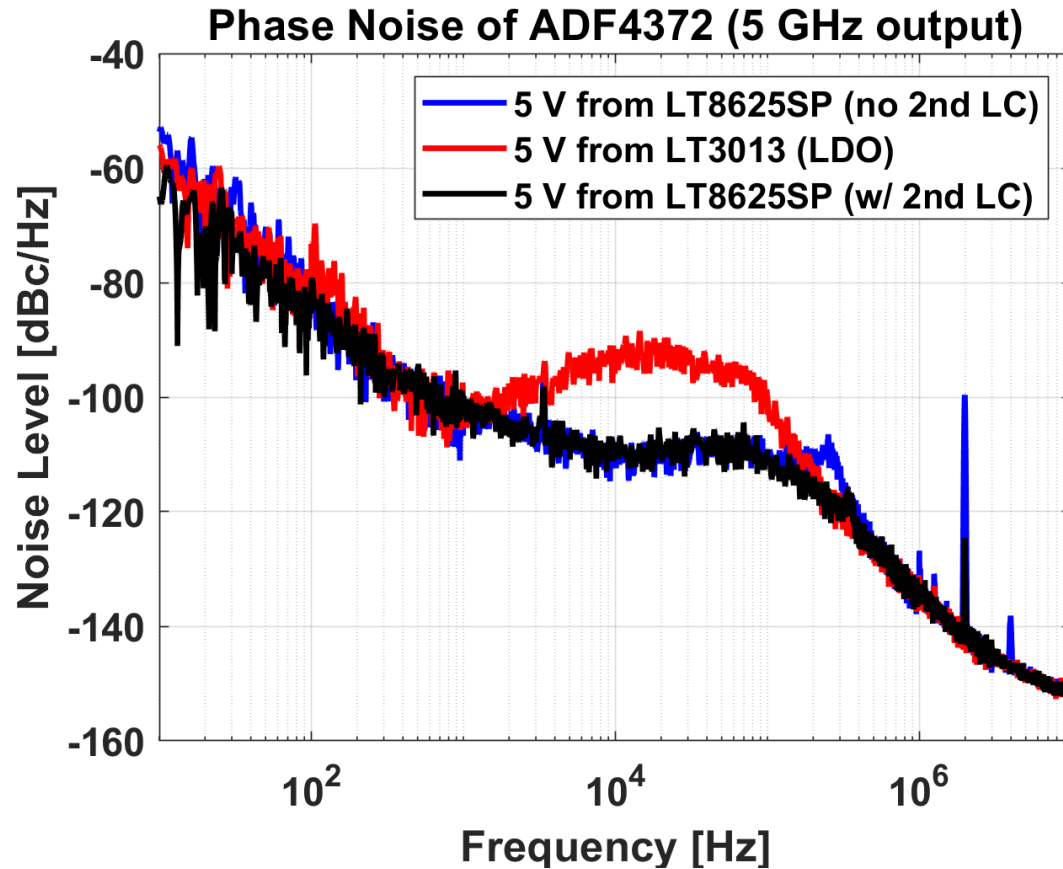
# Silent Switcher 3 vs. Other Switching Regulators

- ▶ Silent Switcher 3 supports much lower phase noise than other switching regulators at 1 kHz-200 kHz frequency range



# Silent Switcher 3 vs. Average LDO

- ▶ Silent Switcher 3 results in better phase noise performance than average LDO (LT3013)





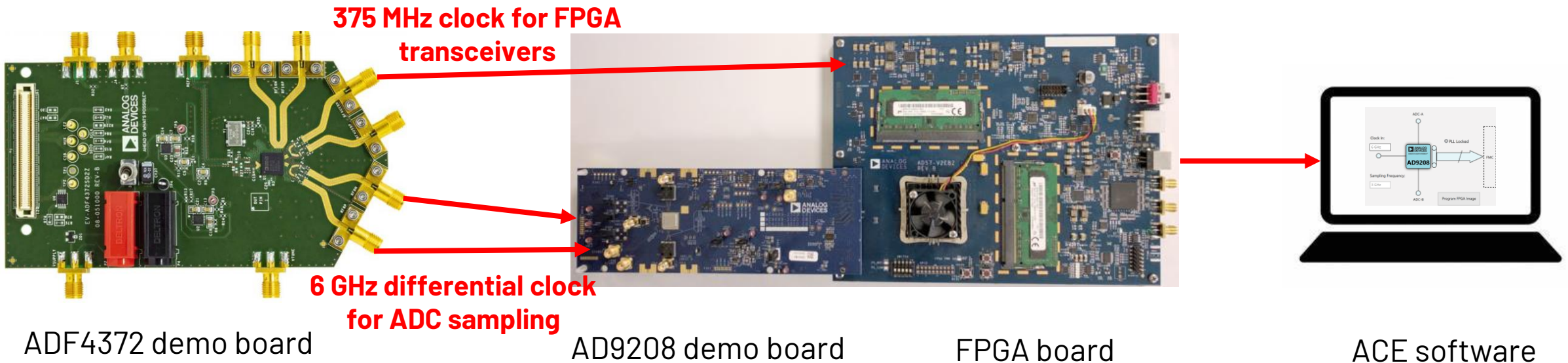
# Case Study: a High Speed ADC System

[analog.com](http://analog.com)



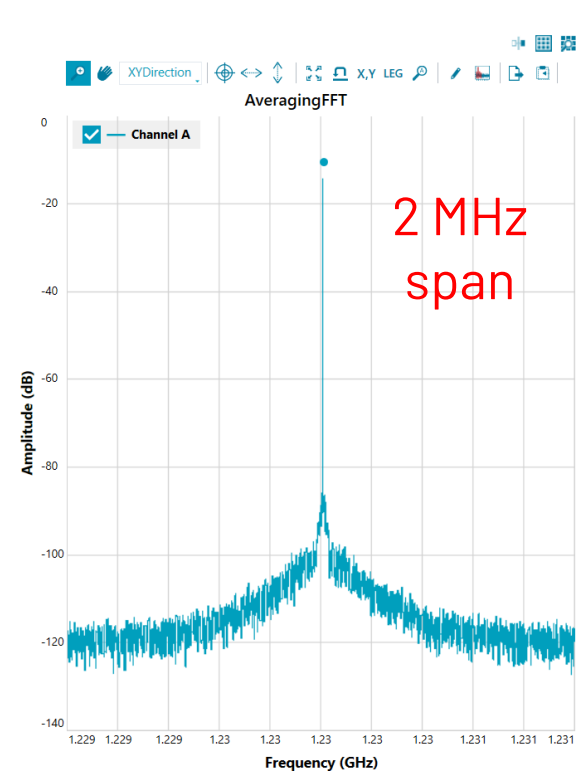
# ADC System Overview

- ▶ AD9208: high-speed 14-bit ADC with 9 GHz bandwidth
- ▶ ADF4372: PLL frequency synthesizer
- ▶ ADF4372 board provides clock signals of ADC system
- ▶ Suitable for a wide range of signal chain applications (5G, ATE, etc)

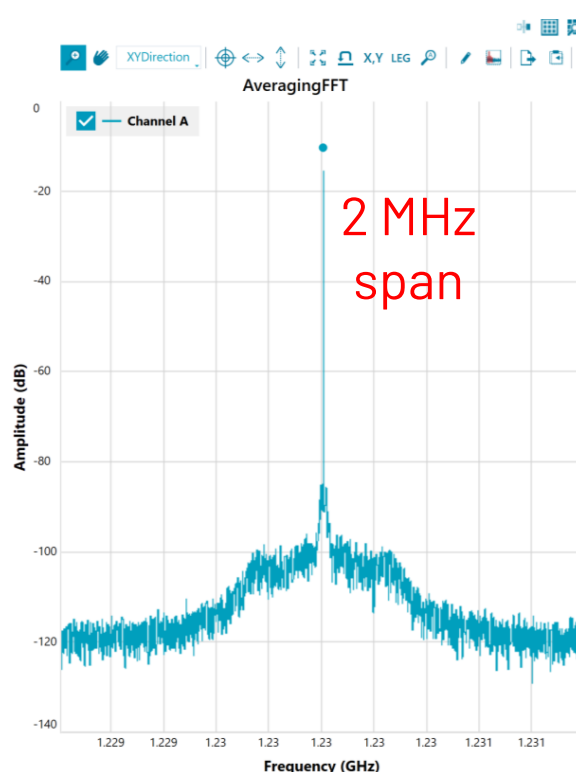


# Comparison: Different 5 V Power Supplies for Sampling Clock

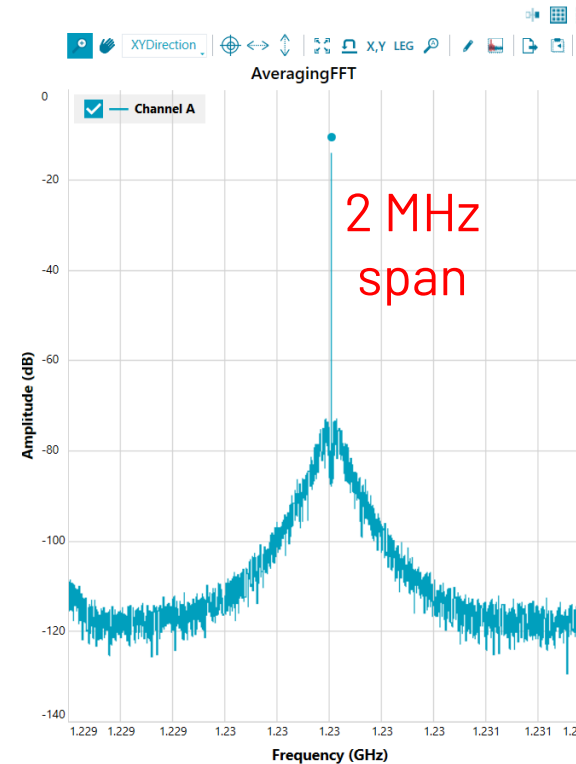
- ▶ Silent Switcher 3 has best performance among switching regulators
- ▶ LTM8024 (SS2 inside) and competitor switcher have worse performance, mainly due to higher noise in low and medium frequency range



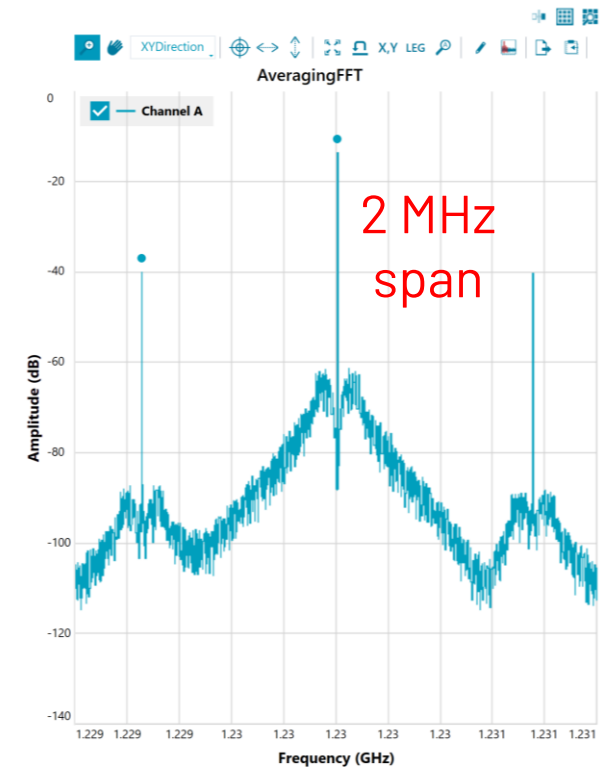
**Ultra-low-noise LDO  
(LT3045)**



**LT8625SP (SS3)  
( $f_{sw}=2$  MHz)**



**LTM8024 (SS2 inside)  
( $f_{sw}=1$  MHz)**

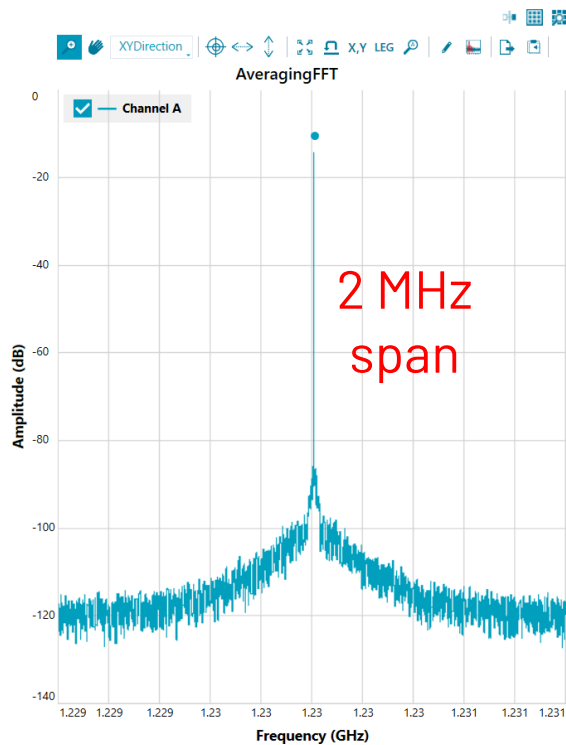


**Competitor T switcher  
( $f_{sw}=0.75$  MHz)**

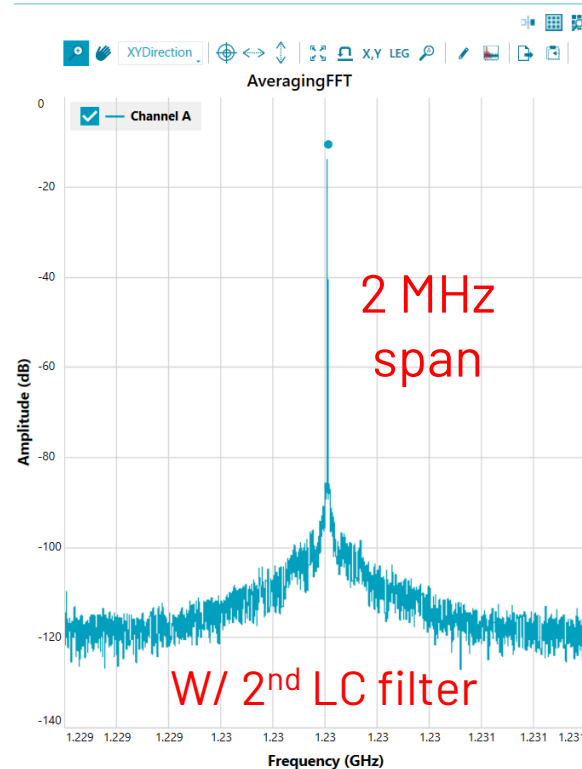
Input: 1.23 GHz, -10 dBFS

# Comparison: Silent Switcher 3 vs. Ultra-low-noise LDO

- ▶ With designed **2<sup>nd</sup> stage LC filter**, Silent Switcher 3 can achieve almost the same ADC performance as ultra-low-noise LDO

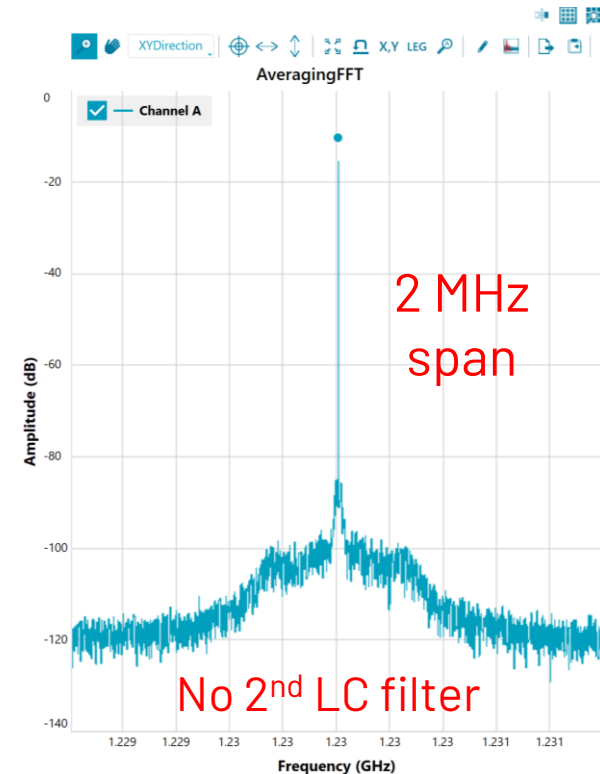


Ultra-low-noise LDO  
(LT3045)



LT8625SP (SS3)  
( $f_{sw}=2$  MHz)

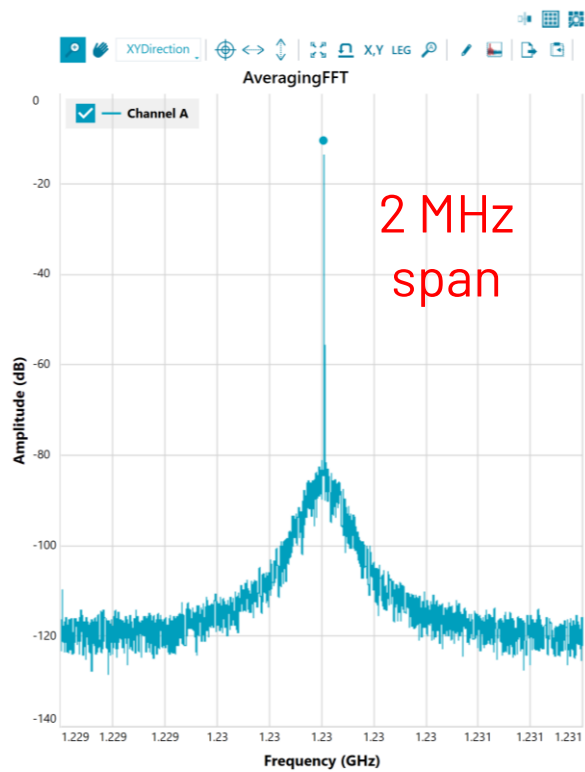
Input: 1.23 GHz, -10 dBFS



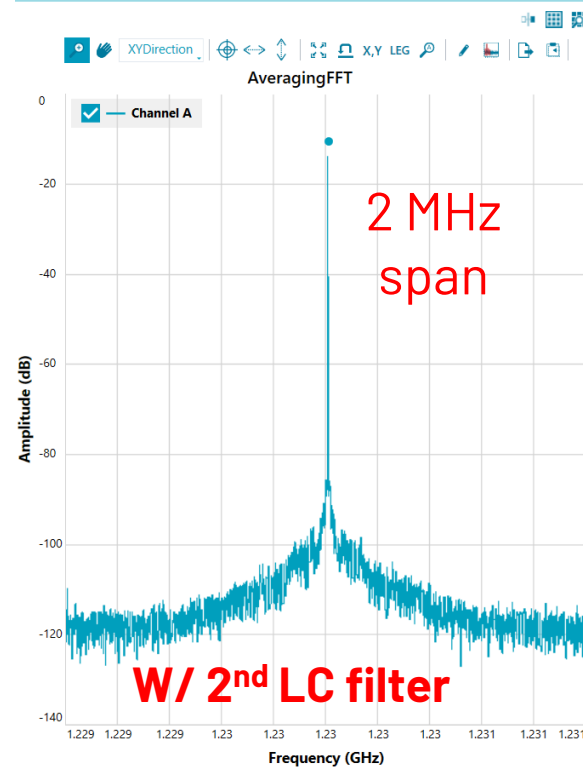
LT8625SP (SS3)  
( $f_{sw}=2$  MHz)

# Comparison: Silent Switcher 3 vs. Average LDO

- ▶ With designed 2<sup>nd</sup> stage LC filter, Silent Switcher 3 supports better ADC performance than an average LDO

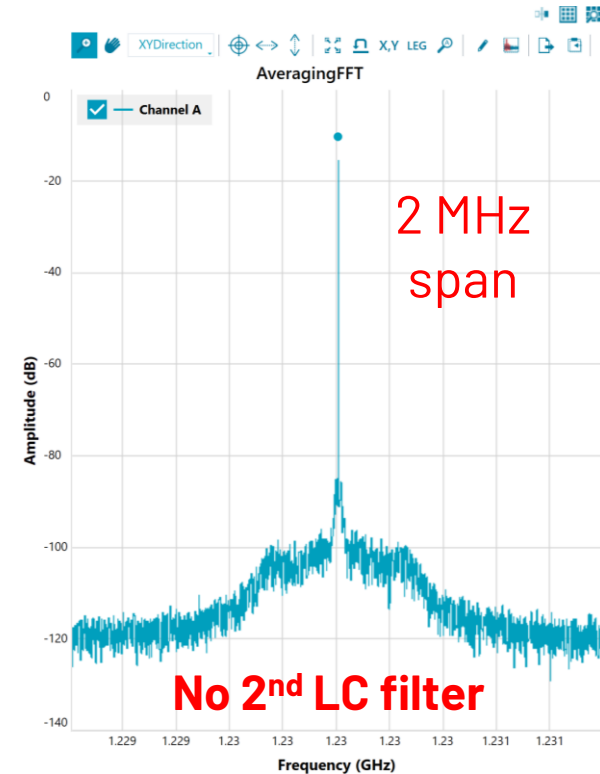


Average LDO  
(LT3013)



LT8625SP (SS3)  
( $f_{sw}=2$  MHz)

Input: 1.23 GHz, -10 dBFS



LT8625SP (SS3)  
( $f_{sw}=2$  MHz)

- ▶ With proper design, Silent Switcher 3 can replace LDOs as power supply of PLL serving as ADC sampling clock

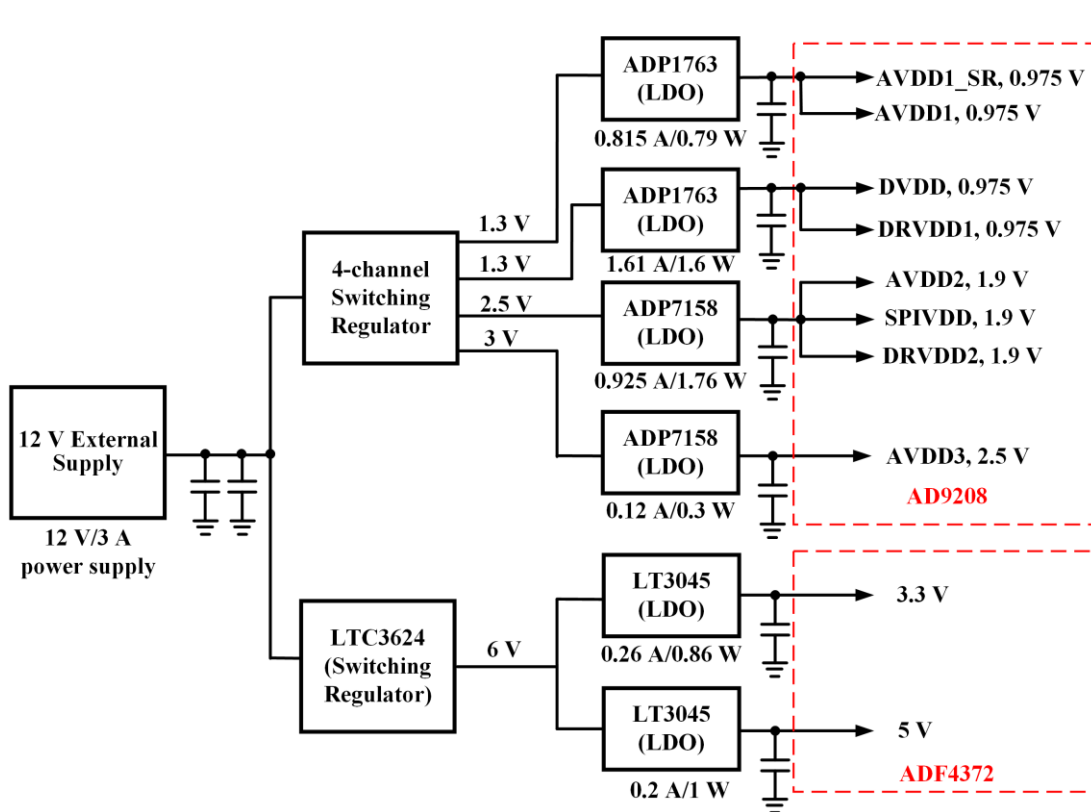
5 V Supply of PLL clock (ADF 4372)	SNR of ADC
Ultra low noise LDO (baseline)	794.3 (58 dBFS)
<b>LT8625SP (w/ 2<sup>nd</sup> LC filter)</b>	<b>794.3 (58 dBFS)</b>
<b>LT8625SP (no 2<sup>nd</sup> LC filter)</b>	<b>758.6 (57.6 dBFS)</b>
Average LDO (LT3013)	767.4 (57.7 dBFS)
LTM8024 (SS2 inside)	126 (42 dBFS)

## SNR (Signal-to-Noise Ratio):

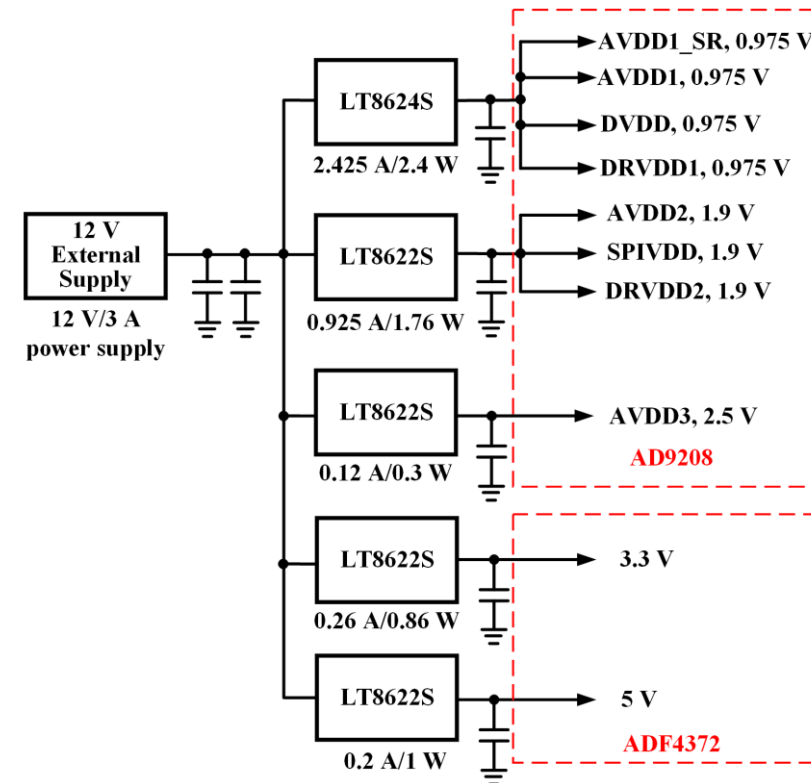
- $SNR = \frac{\text{Carrier Signal}}{\text{Spectral Noise}}$
- Spectral noise: RMS sum of all noise spectral components excluding first 5 harmonics and dc

# Proposed Power Delivery Network of ADC System

- ▶ Simple network based on Silent Switcher 3 can be used to power ADC system
- ▶ LDOs not needed to satisfy power supply requirements



Original power delivery network  
(Buck + LDO solution)



Proposed power delivery network  
based on Silent Switcher 3

Supported by  
previous work  
[1], [2]

Supported by  
this work

[1] John Martin Dela Cruz and Patrick Pasaquian. "Optimizing Power Systems for the Signal Chain—Part 2: High Speed Data Converters." Analog Dialogue

[2] Aldrick Limjoco, Patrick Pasaquian, and Jefferson Eco, "Silent Switcher  $\mu$ Module Regulators Quietly Power GSPS Sampling ADCs in Half the Space." Analog Dialogue

# AHEAD OF WHAT'S POSSIBLE

[analog.com](https://analog.com)

