LMP2011,LMP7711,LP3996,LP5900

Using Power to Improve Signal-Path Performance

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ANALOG edge[SM]

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DESIGN idea

Using Power to Improve Signal-Path Performance

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System-level hardware designers pay careful attention to picking the right analog signal path ICs for their specific applications. Whether designing consumer MP3 players or medical ultrasound equipment, engineers care about making the right trade-offs while maintaining high performance. After reviewing and prioritizing specifications such as Signal-to-Noise Ratio (SNR), resolution, Total Harmonic Distortion (THD), input offset voltage, slew rate, jitter, and supply current, the analog signal path ICs can be selected. Picking the right signal path ICs leads to the best sight and sound experience for the user. Each of these signal path ICs need "clean" power. Often, power management is the last part of the system design. ***Figure 1*** shows an example system of how the signal path is powered.

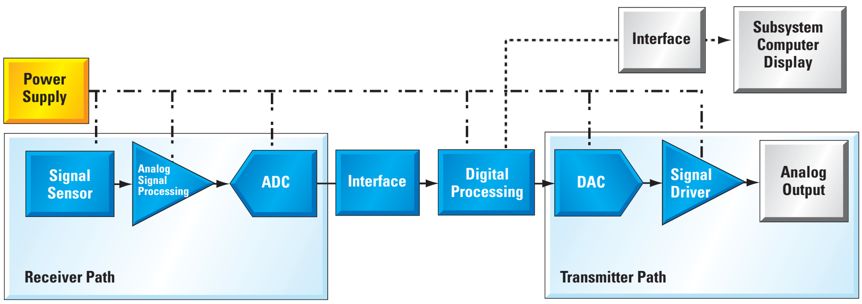

Figure 1. Power Supply Design Affects the Signal Path IC Performance

Not surprisingly, the power supply affects the analog signal integrity which ultimately affects overall system performance. An easy way to improve signal path performance is by selecting the right power supply. When selecting a power supply a key parameter affecting the analog signal path performance is noise or ripple on the power supply line. Noise or ripple on the power supply can couple into the output of an op amp, increase jitter on a Phase-Locked Loop (PLL) or Voltage-Controlled Oscillator (VCO), or degrade the SNR in an ADC. Low noise and ripple on the power supply will also improve signal path performance.

Noise and ripple on the power supply line can come from a number of sources. High-speed data and high-frequency signals within the system itself create noise because Printed Circuit Board (PCB) traces and wiring elements can act like an antenna if not carefully attended to. Digital ICs such as microcontrollers, Field Programmable Gate Arrays (FPGAs) and Complex Programmable Logic Devices (CPLDs) have fast edge rates that draw varying amounts of current and radiate Electromagnetic Interference (EMI) into the system. Silicon ICs generate thermal noise internally which is caused by the random motion and collision of molecules at temperatures above absolute zero Kelvin.

There are three common ways to minimize noise and ripple in the signal path: careful attention to system PCB layout, proper supply bypassing, and choice of the right power supply. Though system-dependent, PCB layout considerations include proper component placement, minimization of signal path trace length, and having a solid ground.

Bypassing the supply rail is a common practice, often recommended in analog ICs datasheets to filter out noise. Signal path ICs can have separate analog, digital, and PLL power supply inputs, each with its own suggested bypassing. The PLL supply and analog supplies are the most sensitive to noise and ripple. Bypass capacitors, resistor-capacitor (RC) filters and EMI suppression filters minimize noise and ripple into the signal path power supply.

NEXT ISSUE:
Optimizing Portable Designs with DACs

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Featured Products

Single Precision, 17 MHz, Low Noise, CMOS Input Amplifier

The LMP7711 (single) and LMP7712 (dual) are low-noise, low-offset, CMOS input, rail-to-rail output precision amplifiers with a high gain bandwidth and an enable pin. The LMP7711/12 are part of the LMP® precision amplifier family and are ideal for a variety of instrumentation applications.

Utilizing a CMOS input stage, the LMP7711/12 achieve an input bias current of 100 fA, an input referred voltage noise of 5.8 nV/√Hz and an input offset voltage of less than ±150 µV. These features make the LMP7711/12 superior choices for precision applications.

Consuming only 1.15 mA of supply current, the LMP7711 offers a high gain bandwidth product of 17 MHz, enabling accurate amplification at high closed loop gains.

Features

- ±150 µV (max) input offset voltage
- 100 fA input bias current
- 5.8 nV/√Hz input voltage noise
- 17 MHz gain bandwidth product
- 1.15 mA supply current (LMP7711)
- 1.30 mA supply current (LMP7712)
- 0.001% THD+N at f = 1 kHz
- -40°C to +125°C operating temperature range
- Rail-to-rail output swing

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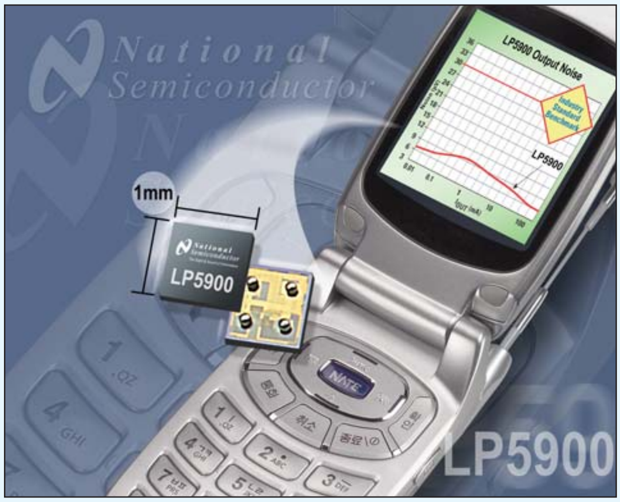
The LMP7711/12 are ideal for use in sensor interface applications, transimpedance amplifiers, and active filters and buffers. The LMP7711/12 are built with National's award-winning advanced VIP50 process technology. The LMP7711 is offered in Thin SOT23-6 packaging and the LMP7712 is offered in a MSOP-10 packaging.

For FREE samples, datasheets, and more, visit
www.national.com/pf/LM/LMP7711.html



Lowest Noise 150 mA CMOS LDO

The LP5900 is a linear regulator capable of supplying 150 mA output current. Designed to meet the requirements of RF/Analog circuits, the LP5900 device provides low noise, high PSRR, low quiescent current, and low line transient response figures. Using new innovative design techniques the LP5900 offers class-leading device noise performance without a noise bypass capacitor.

Features

- Stable with 0.47 µF ceramic input and output capacitors
- No noise bypass capacitor required
- Logic controlled enable
- Thermal-overload and short-circuit protection
- -40°C to +125°C junction temperature range for operation

The LP5900 is ideal for powering analog and RF signal path ICs, including low-noise amplifiers, voltage controlled oscillators, and RF receivers. The device is available in micro SMD and LLP packaging. This device is available with 1.5V, 1.8V, 2.0V, 2.2V, 2.5V, 2.6V, 2.7V, 2.8V, 3.0V, and 3.3V outputs.

For FREE samples, datasheets, and more, visit
www.national.com/pf/LP/LP5900.html

Using Power to Improve Signal-Path Performance

The right power supply can reduce noise and ripple to the signal path IC. When choosing a power supply the designer first makes a basic choice between a switching converter and a linear regulator. A switching converter provides higher efficiency which translates to less power consumption in the overall system. A linear regulator provides an easy-to-use solution while lowering the noise /ripple on the supply rail. Use a linear regulator to improve signal path performance by reducing noise and ripple.

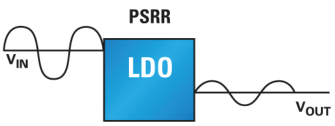


Figure 2. Power Supply Rejection Ratio (PSRR) is a Measure of How Much Ripple/Noise Attenuates From Input to Output

Analog signal path ICs specify how well the part rejects noise and ripple on the power supply line. The parameter is called Power Supply Rejection Ratio (PSRR); see *Figure 2*. It is the ratio of the noise/ripple coming into the device to the noise/ripple going out of the device. PSRR is measured in decibels (dB) and the equation is:

$$dB = 20 \log_{10} \frac{V_1}{V_2}$$

where V1 is the change in input voltage and V2 is the change in output voltage. Using this equation yields a negative value. Don't be concerned if you see suppliers specifying PSRR as a positive value; this means they used the ratio V2/V1 instead of V1/V2. Take the absolute value of PSRR to avoid confusion. Designers want the highest absolute value PSRR which correlates to low noise/ripple on the output. As an example 80 dB (output ripple is 10,000x smaller than the input ripple) is better than 20 dB (output ripple is 10x smaller than the input ripple).

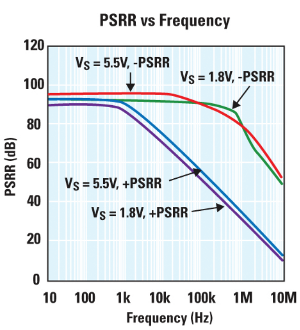


Figure 3. LMP7711 Single, High Precision Op Amp PSRR Over Frequency

Figure 3 shows a PSRR graph for the LMP7711 high precision op amp. The LMP7711 is a high precision op amp with a PSRR of 90 dB at 1 kHz. Two things to note are PSRR exists for both the positive and negative rail and also PSRR degrades (absolute value decreases) as the frequency of the ripple increases.

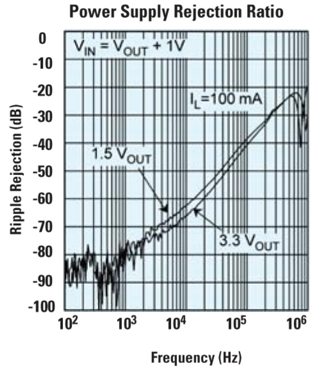


Figure 4. LP5900 150 mA Low Dropout Linear Regulator PSRR Over Frequency

Using a linear regulator to power the signal path reduces noise/ripple because a linear regulator also rejects noise/ripple from its input to its output. The LP5900 is a low noise 150 mA LDO with a PSRR of 85 dB at 1 kHz (see *Figure 4*). Using the LP5900 (low noise LDO) to power the LMP2011 (high precision op amp) reduces the noise/ripple on the power supply (*Figure 5*). 1 kHz ripple/noise is rejected by the LDO at 85 dB and then also rejected by the precision op amp at 90 dB.

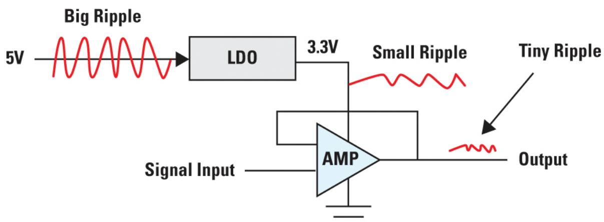


Figure 5. Using a Linear Regulator to Power an Amplifier Reduces Noise/Ripple in the Analog Signal Path

A simple way to improve the signal path performance in an application is to use a linear regulator to power the signal path ICs. Linear regulators provide an easy way to generate the needed power supply rails while also rejecting noise/ripple on the power supply line. ■

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Featured Products

Micropower 800 mA Low-Noise, Ceramic-Stable Adjustable Voltage Regulator

The LP3878-ADJ is an 800 mA adjustable output voltage regulator designed to provide high performance and low noise in applications requiring output voltages as low as 1.0V. Using an optimized VIP™ (Vertically Integrated PNP) process, the LP3878-ADJ delivers superior performance. The ground pin current is typically 5.5 mA at 800 mA load, and 180 µA at 100 µA load. The LP3878-ADJ draws less than 10 µA quiescent current when shutdown pin is pulled low. Guaranteed output voltage accuracy is 1% at room temperature. Broadband output noise is only 18 µV (typical) with 10 nF bypass capacitor.

Features

- 1.0V to 5.5V output
- Designed for use with low ESR ceramic capacitors
- Very low output noise
- <10 µA quiescent current in shutdown
- Low ground pin current at all loads
- Over-temperature/over-current protection
- -40°C to +125°C operating junction temperature range

The LP3878 is ideal for use in ASIC power supplies in desktop and notebook computers, graphic cards, set-top boxes, printers, copiers, DSP and FPGA power supplies, SMPS post-regulators, and medical instrumentation. It is available in PSOP-8 and LLP-8 surface-mount packaging.

For FREE samples, datasheets, and more, visit
www.national.com/pf/LP3878.html

Dual Linear Regulator with 300 mA and 150 mA Outputs and Power-On-Reset

The LP3996 is a dual low dropout regulator with power-on-reset circuit. The first regulator can source 150 mA, while the second is capable of sourcing 300 mA and has a power-on-reset function included. The LP3996 provides 1.5% accuracy requiring an ultra-low quiescent current of 35 µA. Separate enable pins allow each output of the LP3996 to be shut down, drawing virtually zero current. The LP3996 is designed to be stable with small footprint ceramic capacitors down to 1 µF. An external capacitor may be used to set the POR delay time as required.

Features

- 2 LDO outputs with independent enable
- 1.5% accuracy at room temperature, 3% over temperature
- Power-on-reset function with adjustable delay
- Thermal shutdown protection
- Stable with ceramic capacitors
- Input voltage range: 2.0V to 6.0V
- Low dropout voltage: 210 mV at 300 mA
- Ultra-low I_q (enabled) 35 µA
- Virtually zero I_q (disabled) <10 nA

The LP3996 is ideal for use in cellular phones, PDAs, and wireless network adapters. The LP3996 is available in LLP-10 packaging.

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