

HITTITE LAUNCHES NEW DC POWER CONDITIONING PRODUCT LINE!



Feature Article from Hittite Microwave Corporation

High PSRR Linear Voltage Regulator is Ideal for Low Noise, Mixed-Signal Applications

Electronic systems today are primarily digital in nature, and many of the sub-system circuits tend to be dominated by DSPs, FPGAs, DRAMs, and ASICs as well as memory, microprocessor, and other digital logic devices. The number of power rails in many applications has increased dramatically over the last few years, and complex systems such as cellular base stations, microwave radio, telecom and radar often have line cards with more than ten voltage rails. Such systems often employ a large number of DC-to-DC switching regulator ICs to generate the many voltage rails required. DC-to-DC switching regulator ICs usually comprise non-isolated controllers with integrated switching FETs.

The downside of DC-to-DC switching regulators is that they tend to generate strong spurious components along with high thermal noise levels at high frequencies on all of the power supply rails, which can then propagate throughout the entire system. This is not usually a problem for digital circuits, since switching interference is usually below the inherent noise immunity of the digital circuits. However, this type of switching regulator cannot normally be used to supply DC power to sensitive RF and Microwave circuits such as PLLs, VCOs, or very low noise receiver components. These high frequency, high performance circuits cannot tolerate switching spurious and high power supply noise.

How can designers of sensitive analog mixed-signal circuits embedded in digital sub-systems be assured of the clean power rails that they need for correct operation? Fortunately, Hittite Microwave has recognized this problem

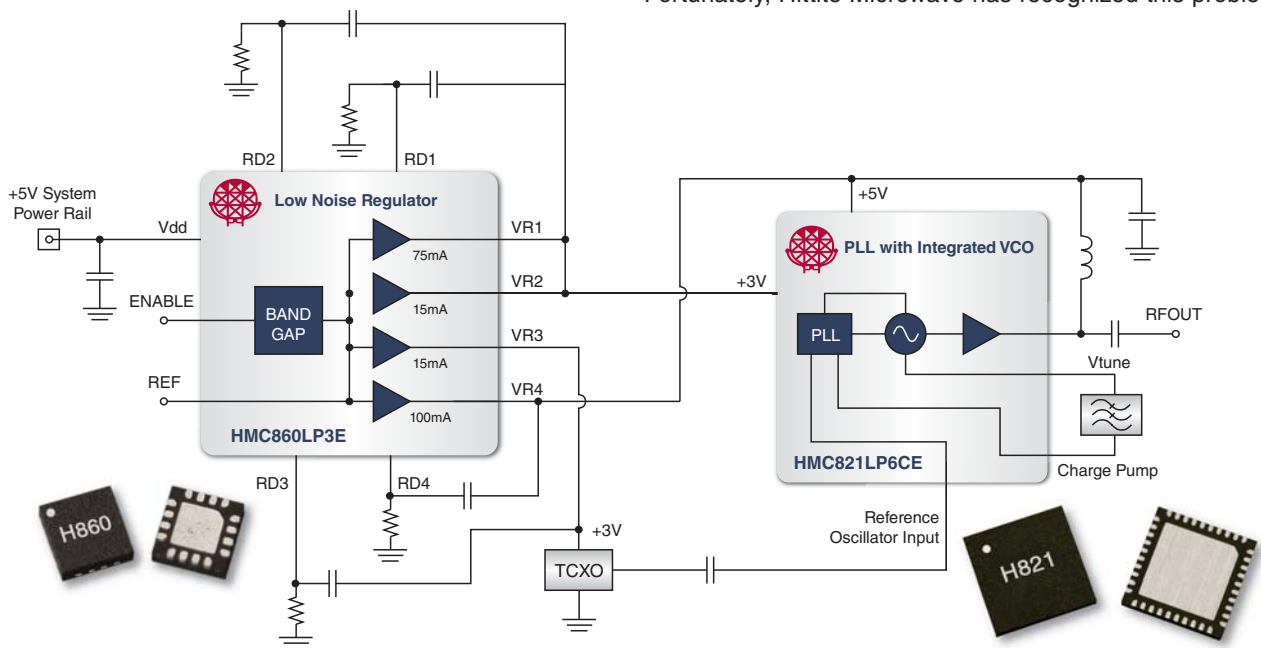


Figure 1: HMC860LP3E Low Noise Regulator Powering a Hittite PLL with Integrated VCO

DC POWER CONDITIONING PRODUCT LINE IS IDEAL

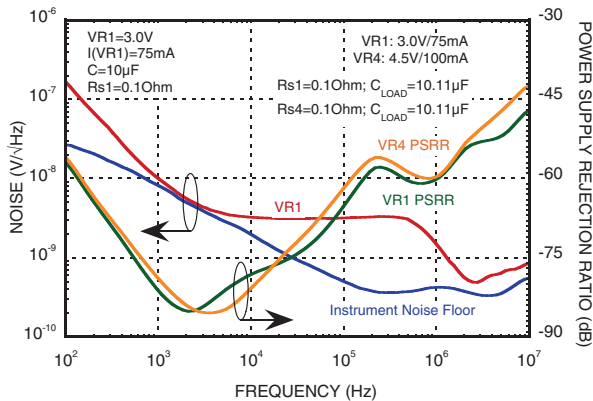


Figure 2: HMC860LP3E Noise Spectral Density and VR1, VR4 PSRR vs. Frequency (Hz)

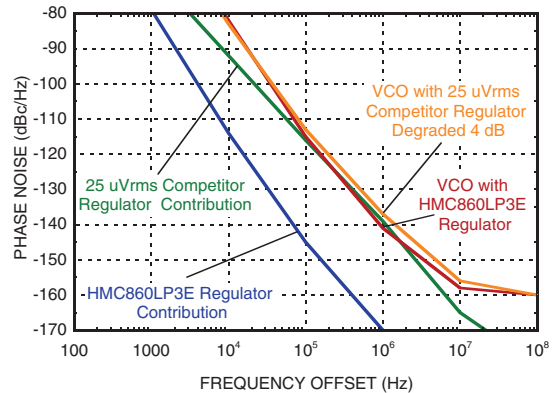


Figure 3: Comparison of Regulator Contribution to Phase Noise

and developed a solution in the form of the HMC860LP3E low noise regulator. This new IC provides a compelling combination of low noise and high PSRR (Power Supply Rejection Ratio) in a quad regulator.

All low noise analog components are affected to some extent by the noise on their power supply. In fact, the power spectral density of the power supply noise directly translates onto the system output once mixing and filtering are taken into account. As an example, the ideal phase noise of a VCO measured with a perfect battery supply will always be degraded somewhat by a real system power supply. But the question is, by how much? The VCO phase noise contribution from the system power supply will be given by: $20 \log_{10} (V_n(f_m) \cdot k_p / 2f_m)$.

For example, if the regulator noise density, $V_n(f_m)$ is white and equal to $3 \text{ nV}/\sqrt{\text{Hz}}$, and the power supply pushing figure of the VCO, k_p , is $10 \text{ MHz}/\text{V}$, then the phase noise contribution of the power supply at $f_m = 100 \text{ kHz}$ offset would be $-136 \text{ dBc}/\text{Hz}$. This number will be directly affected dB for dB by the power supply. While the transfer function from the power supply to the system output is different for different types of analog components, the concept is the same. In short, the noise density of the system power supply degrades the system.

By using low noise RF design principles together with low noise BiCMOS technology, Hittite has created the HMC860LP3E low noise regulator, which delivers the industry's lowest noise floor in a linear voltage regulator.

Figure 2 shows a plot of noise spectral density versus frequency for the VR1 voltage output with a supply voltage of 5.5 V. The plot shows excellent noise density performance of $7 \text{ nV}/\sqrt{\text{Hz}}$ at 1 kHz, and $3 \text{ nV}/\sqrt{\text{Hz}}$ at 10 kHz - values which approach the thermal noise floor.

In many systems, emphasis on the design of the power supply is secondary to the system function design. The RF and Microwave subsystem designer is often left with the challenging problem of how to specify the noise densities of the supplies. Systems with feedback and filters complicate the calculations needed to specify the power supply noise densities. Cut and try approaches are common and often leave the designer with a pressing delivery deadline and a board that can't be changed. Hittite has solved this problem for PLL design by modeling and incorporating the power supplies into our PLL design software. Modeling the supply noise prior to designing the board can save a project with a tight time line. The PLL design software is available from Hittite by contacting apps@hittite.com.

High efficiency, low cost DC-to-DC switching regulators tend to generate very large spurious components at 100s of kHz. The HMC860LP3E low noise regulator is able to strongly suppress these noise spikes since the device exhibits high PSRR of up to 80 dB at 1 kHz, and better than 50 dB at 1 MHz. The HMC860LP3E low noise regulator also provides four voltage outputs which are adjustable from 2.5 V to 5.2 V, and are ideal for conditioning the DC power supply to Hittite's frequency generation sub-systems. Each of the four voltage outputs can be adjusted higher or lower

FOR POWERING HITTITE'S PLL + VCO PRODUCTS

than the default value by using one external resistor, or each output can be set to +5 V by grounding the appropriate pin. Each of the four outputs can be also be tied together with similarly configured voltage outputs to achieve the required output current.

For example, Figure 1 shows the implementation of a Hittite RF PLL with integrated VCO. Here, the HMC860LP3E low noise regulator is used to supply the +3 V rail and the +5 V rail to the HMC821LP6CE RF PLL with integrated VCO, and the +3 V supply to the 50 MHz crystal oscillator. The supply of the +3 V rail is achieved by tying the VR1 and VR2 outputs together to increase the current drive capability to 90 mA. Complex mixed-signal analog subsystems often require isolation between various components, and tying all of the analog supplies together can compromise performance. The HMC860LP3E low noise regulator addresses this subtle problem by providing more than 40 dB of isolation up to 10 MHz between any two outputs.

The phase noise of the HMC821LP6CE PLL with VCO with the HMC860LP3E low noise regulator was compared with using a competitor's low noise regulator. The contribution of each regulator to the output phase noise is shown in Figure 3. The results show that the phase noise contribution from the HMC860LP3E regulator was more than 20 dB better than the phase noise of the HMC821LP6CE PLL with VCO at all offsets. This is a clear indication that the HMC860LP3E regulator allows the full performance of the HMC821LP6CE to be realized.

In contrast, the competitor's 25 uVrms regulator contribution dominates the output phase noise at 100 kHz and 1 MHz, and makes a measurable contribution to phase noise at 10 kHz. The regulator should never contribute to the system phase noise performance, let alone dominate it!

The HMC860LP3E low noise regulator can be powered down via its TTL-compatible enable (EN) input to consume <1 μ A. This device is ideal for supplying clean, regulated

power to Hittite's family of eight new SMT packaged PLLs with integrated VCOs: HMC820LP6CE, HMC821LP6CE, HMC822LP6CE, HMC824LP6CE, HMC826LP6CE, HMC828LP6CE, HMC831LP6CE, and the HMC836LP6CE. This family of SiGe PLL with integrated VCO RFICs provides output frequency coverage from 660 MHz to 5.1 GHz, and delivers SSB phase noise as low as -115 dBc/Hz at 10 kHz offset, with up to +10 dBm output power. High output power and low spurious performance enables these PLL with integrated VCO products to directly drive the frequency converter or direct modulator in many of today's cellular/4G systems. The HMC860LP3E low noise regulator will also help deliver the best phase noise performance from Hittite's popular GaAs and SiGe PLL, PLO, VCO, frequency divider and phase-frequency detector products.



HMC860LP3E Low Noise Voltage Regulator

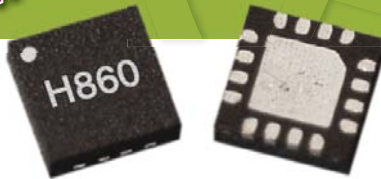
Ideal for low noise voltage regulation in automotive telematics, cellular/3G, WiMAX/4G, military and test equipment applications, the HMC860LP3E low noise regulator is housed in a compact, RoHS compliant 3x3 mm QFN SMT package and is specified for operation from -40°C to +85°C. The HMC860LP3E low noise regulator is included in many of Hittite's RF PLL w/integrated VCO Evaluation Kits. Samples and evaluation PC boards are available from stock. Data sheets and supporting information for Hittite's products are available online at www.hittite.com.

DC POWER CONDITIONING

Linear Voltage Regulator for Demanding Low Phase Noise VCO/PLL Applications!

Analog, Digital & Mixed-Signal
ICs, Modules, Subsystems & Instrumentation

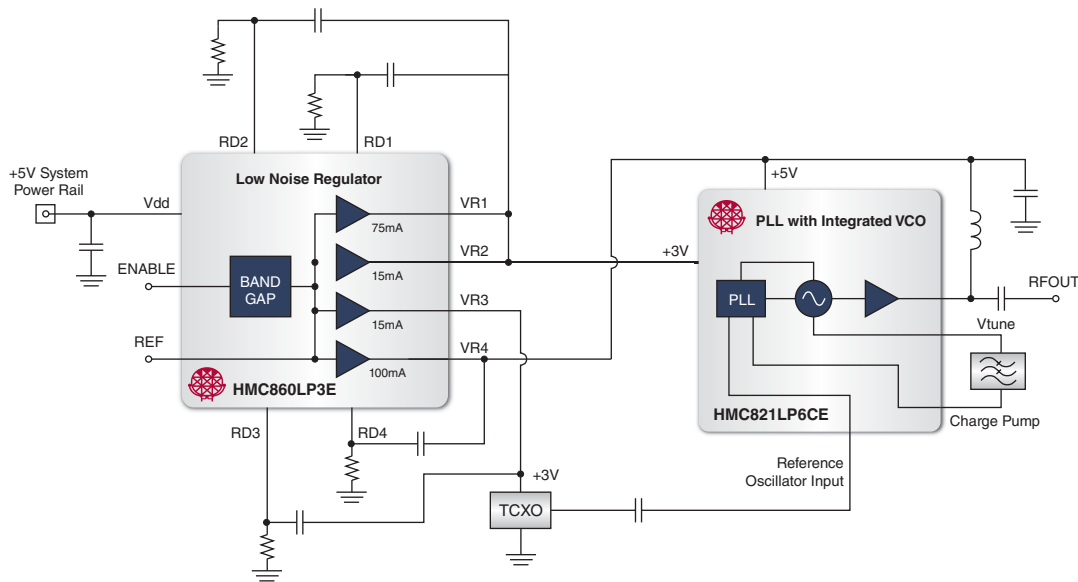
NEW!



1µA Power Down Current

HMC860LP3E Quad Output Low Noise High PSRR Linear Voltage Regulator

- ◆ **Low Noise Spectral Density:**
 - 3 nV/√Hz @ 10 kHz
 - 7 nV/√Hz @ 1 kHz
- ◆ **High PSRR:**
 - 80 dB @ 1 kHz
 - 60 dB @ 1 MHz
- ◆ **Four Voltage Outputs:**
 - VR1 = 3 V @ 75 mA
 - VR2, VR3 = 3V @ 15 mA
 - VR4 = 4.5 V @ 100 mA
- ◆ **All Outputs Are Adjustable**
From 2.5 V to 5.2 V



HIGH PSRR - QUAD LINEAR VOLTAGE REGULATOR - *New Product Line!*

Input Voltage (V)	Function	Output Voltage (V)	Output Current (mA)	Power Supply Rejection Ratio (PSRR) (dB)		Output Noise Spectral Density (nV/√Hz)		Regulated Outputs	Package	Part Number
				1 kHz	1 MHz	1 kHz	10 kHz			
3.35 - 5.6	Quad Voltage Regulator	2.5 - 5.2	15 - 100	80	60	7	3	4	LP3	HMC860LP3E

Ideal for Powering Hittite's Broad Line of Frequency Generation Products Including Our Low Noise PLLs with Integrated VCOs!