LINEAR TECHNOLOGY

DESIGN NOTES

Lowest Noise SOT-23 LDOs Have 20µA Quiescent Current, 20µV_{RMS} Noise – Design Note 220

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Telecom and instrumentation applications often require a low noise voltage regulator. Frequently this requirement coincides with the need for low regulator dropout and small quiescent current. LTC recently introduced a family of devices to address this problem. Table 1 shows a variety of packages, power ranges and features in three basic regulator types. The SOT-23 packaged LT®1761 has only 20µV_{RMS} noise with 300mV dropout at 100mA. Quiescent current is only 20µA.

Applying the Regulators

Applying the regulators is simple. Figure 1 shows a minimum parts count, 3.3V output design. This circuit appears similar to conventional approaches with a notable exception: a bypass pin (BYP) is returned to the output via a 0.01µF capacitor. This path filters the internal reference's output, minimizing regulator output noise. It is the key to the 20µV_{RMS} noise performance. A shutdown pin ($\overline{SHDN}$), when pulled low, turns off the regulator output while keeping current drain inside 1µA. Dropout characteristics appear in Figure 2. Dropout scales with output current, falling to less than 100mV at low currents.

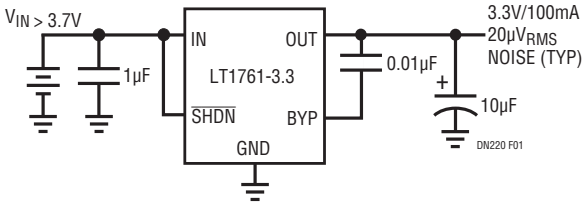

Figure 1. Applying the Low Noise, Low Dropout, Micropower Regulator. Bypass Pin and Associated Capacitor are Key to Low Noise Performance

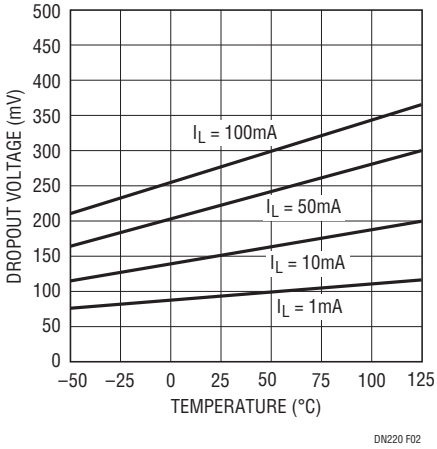

Figure 2. Figure 1's Dropout Voltage at Various Currents

Table 1. Low Noise LDO Family Short-Form Specifications. Quiescent Current Scales with Output Current Capability, Although Noise Performance Remains Constant

REGULATOR TYPE	OUTPUT CURRENT	RMS NOISE (10Hz to 100kHz) C_{BYP} = 0.01µF	PACKAGE OPTIONS	FEATURES	QUIESCENT CURRENT	SHUTDOWN CURRENT
LT1761	100mA	20µV	SOT-23	Shutdown, Reference Bypass, Adjustable Output. SOT-23 Package Mandates Selecting Any Two Features	20µA	<1µA
LT1762	150mA	20µV	MS8	Shutdown, Reference Bypass, Adjustable Output	25µA	<1µA
LT1763	500mA	20µV	SO-8	Shutdown, Reference Bypass, Adjustable Output	30µA	<1µA

Noise Performance

Noise performance is displayed in Figure 3. This measurement was taken in a 10Hz to 100kHz bandwidth with a "brick wall" multipole filter[1]. The photo's trace, applied to a thermally responding RMS voltmeter, contains less than $20\mu V_{RMS}$ noise. Figure 4 shows noise in the frequency domain with noise power falling with increasing frequency.

Other Advantages

The LT1761 family is stable (no output oscillation) even when used with low ESR ceramic output capacitors. This is in stark contrast to LDO regulators from other manufacturers that often oscillate with ceramic capacitors.

The unique internal architecture provides an added bonus in transient performance when adding a 0.01µF noise capacitor. Transient response for a 10mA to 100mA step with a 10µF output capacitor is shown in Figure 5. Figure 6 shows the same setup with the addition of a 0.01µF bypass capacitor. Settling time and amplitude are markedly reduced.

Conclusion

These devices provide the lowest available output noise in a low dropout regulator without compromising other parameters. Their performance, ease of use and versatility allow use in a variety of noise-sensitive applications.

[1]Noise measurement and specification of regulators requires care and will be comprehensively treated in a forthcoming LTC Application Note.

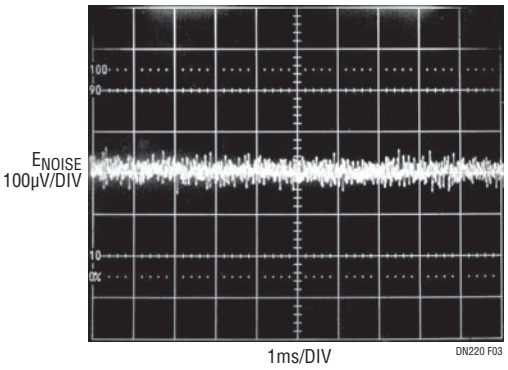

Figure 3. LT1761 Output Voltage Noise in a 10Hz to 100kHz Bandwidth. $20\mu V_{RMS}$ Noise is the Lowest Available in an LDO

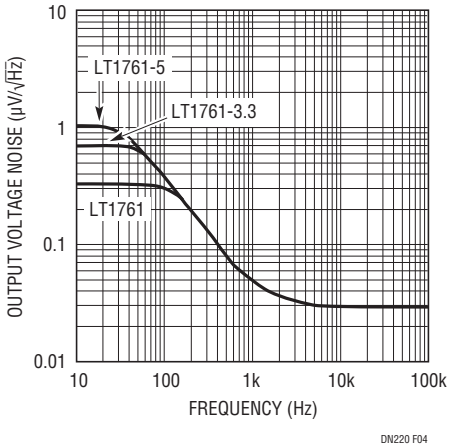

Figure 4. Output Noise Spectral Density for Figure 1's Circuit. Curves for Three Output Versions Show Dispersion Below 200Hz

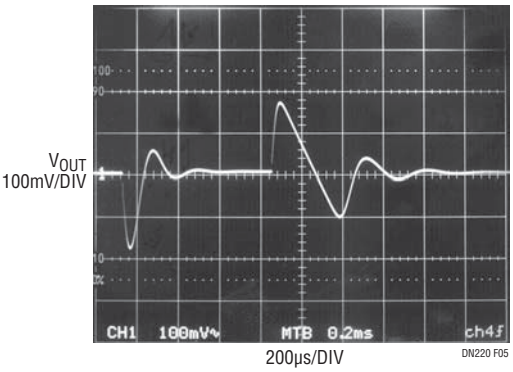

Figure 5. Transient Response with No Noise Bypass Capacitor

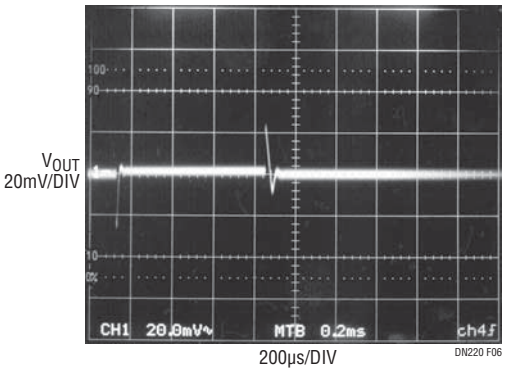

Figure 6. Noise Bypass Capacitor Improves Transient Response. Note Change in Voltage Scale

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