Lowest Noise SOT-23 LDOs Have 20μA Quiescent Current, 20μVRMS Noise – Design Note 220
Todd Owen and Jim Williams

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 20μVRMS 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 20μVRMS noise performance. A shutdown pin (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.

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

<table>
<thead>
<tr>
<th>REGULATOR TYPE</th>
<th>OUTPUT CURRENT</th>
<th>RMS NOISE (10Hz to 100kHz)</th>
<th>PACKAGE OPTIONS</th>
<th>FEATURES</th>
<th>QUIESCENT CURRENT</th>
<th>SHUTDOWN CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT1761</td>
<td>100mA</td>
<td>20μV</td>
<td>SOT-23</td>
<td>Shutdown, Reference Bypass, Adjustable Output. SOT-23 Package Mandates Selecting Any Two Features</td>
<td>20μA</td>
<td>&lt;1μA</td>
</tr>
<tr>
<td>LT1762</td>
<td>150mA</td>
<td>20μV</td>
<td>MS8</td>
<td>Shutdown, Reference Bypass, Adjustable Output</td>
<td>25μA</td>
<td>&lt;1μA</td>
</tr>
<tr>
<td>LT1763</td>
<td>500mA</td>
<td>20μV</td>
<td>SO-8</td>
<td>Shutdown, Reference Bypass, Adjustable Output</td>
<td>30μA</td>
<td>&lt;1μA</td>
</tr>
</tbody>
</table>
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. The photo’s trace, applied to a thermally responding RMS voltmeter, contains less than 20μVRMS 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.

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