LINEAR TECHNOLOGY

DESIGN NOTES

Tiny Dual Full-Bridge Piezo Motor Driver Operates from Low Input Voltage – Design Note 436

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Introduction

Piezoelectric motors are used in digital cameras for autofocus, zooming and optical image stabilization. They are relatively small, lightweight and efficient, but they also require a complicated driving scheme. Traditionally, this challenge has been met with the use of separate circuits, including a step-up converter and an oversized generic full-bridge drive IC. The resulting high component count and large board space are especially problematic in the design of cameras for ever shrinking cell phones. The LT®3572 solves these problems by combining a step-up regulator and a dual full-bridge driver in a 4mm × 4mm QFN package. Figure 1 shows a typical LT3572 Piezo motor drive circuit. A step-up converter is used to generate 30V from a low voltage power source such as a Li-Ion battery or any input power source within the part's wide input voltage range of 2.7V to 10V. The high output voltage of the step-up converter, adjustable up to 40V, is available for the drivers at the V_{OUT} pin. The drivers operate in a full-bridge fashion, where the OUTA and OUTB pins are the same polarity as the PWMA and PWMB pins, respectively, and the $\overline{OUTA}$ and $\overline{OUTB}$ pins are inverted from PWMA and PWMB, respectively. The step-up converter and both Piezo drivers have their own shutdown control. Figure 2 shows a typical layout .

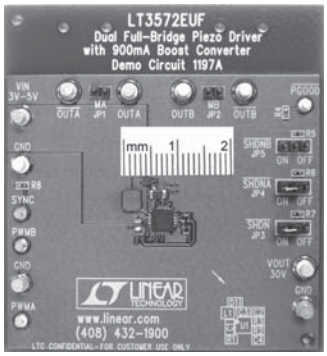

Figure 2. Typical Layout for the Figure 1 Converter

Single Driver Application

Each full-bridge Piezo driver can be independently enabled and disabled by controlling the $\overline{SHDNA}$ and $\overline{SHDNB}$ pins. When held below 0.3V, $\overline{SHDNA}$ and $\overline{SHDNB}$ prevent the drivers from switching and keep the outputs in a high impedance state.

In applications where only one driver is used, the unused driver can be simply turned off without wasting any power by tying either $\overline{SHDNA}$ or $\overline{SHDNB}$ pin to the GND. Figure 3 shows a typical single driver application circuit where only driver A is enabled. The input pin PWMB is tied to GND.

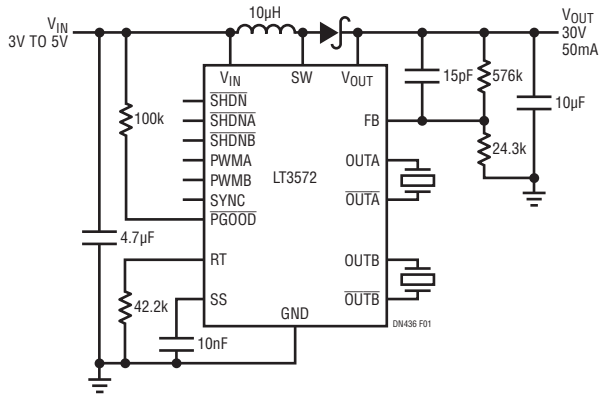

Figure 1. Typical Circuit

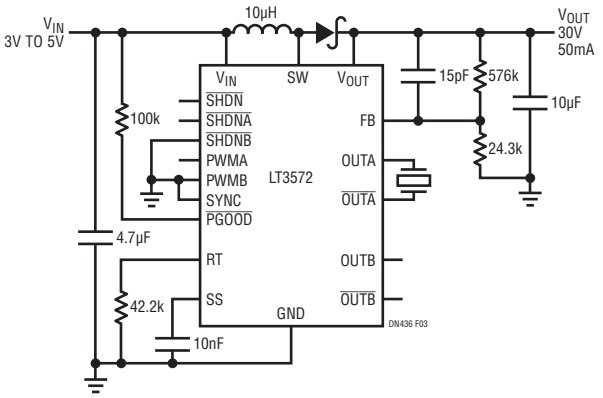

Figure 3. Single Driver Application Circuit

Using External Power Supply

The high output voltage of the step-up converter, adjustable up to 40V, is available for the drivers at the V_{OUT} pin. For some multiple Piezo motor applications with multiple LT3572s, all the full-bridge drivers are powered by an external high voltage power supply. In this case, the integrated step-up converter can be simply disabled and only the dual drivers are used. In Figure 4, the $\overline{SHDN}$ pin is tied to the ground so the step-up regulator is prevented from switching. The SW pin, RT pin, SS pin and $\overline{PGOOD}$ pin are left open. The V_{IN} pin should be connected to a voltage source between 2.7V and 10V and FB pin to any voltage between 1.3V and 3V. In this example, the V_{IN} pin and FB pin are connected together, and both drivers are fully functional while the step-up converter is not running. The V_{IN} current is normally below 10mA.

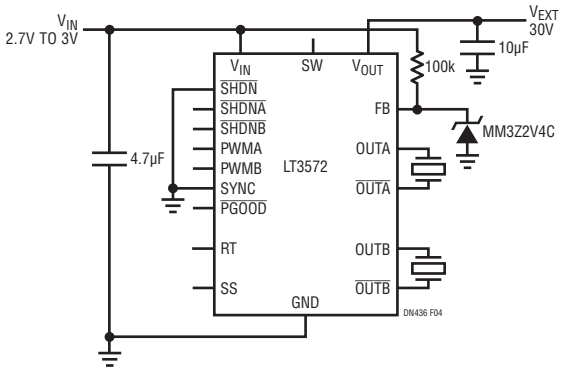

Figure 4. Using External Power Supply with Integrated Step-Up Converter Disabled

Operating Piezo Motor with Long Wires

In some cases, the Piezo motors are physically located far away from the driver. The parasitic inductance of the long connecting wires and capacitive Piezo motor form a high Q resonant LC tank. If the oscillation is not properly dampened, the driver pins would see large negative voltages, possibly causing spurious operation of the IC. Schottky diodes can be added at the OUTA and OUTB pins to prevent ICs from seeing large negative voltage. Another way to solve this problem is to add a resistor between the driver and the Piezo motor, as shown in Figure 5, to slow down the driving speed and dampen the oscillation. In this example, the connecting wires are 1-foot long twisted wires and the resistor is 20Ω. The voltage waveforms of the $\overline{OUTB}$ pin are shown in Figure 6 without the resistor, and Figure 7 with the resistor.

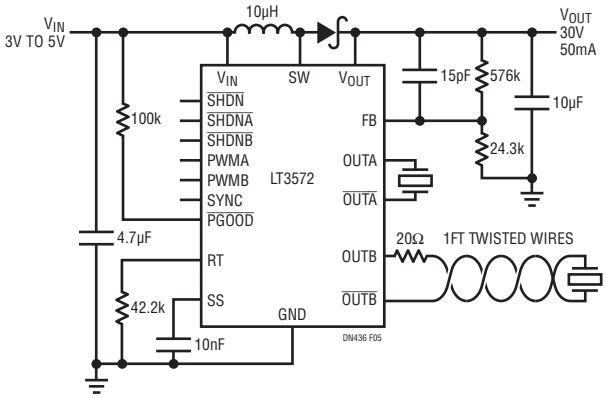

Figure 5. Adding a Resistor when Operating with Long Wires

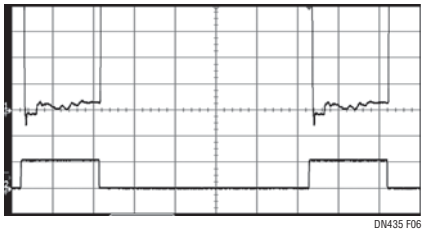

Figure 6. $\overline{OUTB}$ Voltage Without the Resistor. Top Trace: $\overline{OUTB}$ Voltage (2V/Div), Bottom Trace: PWMB Voltage (2V/Div)

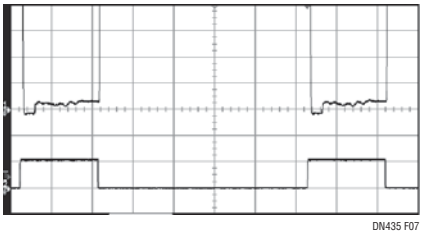

Figure 7. $\overline{OUTB}$ Voltage with the Resistor. Top Trace: $\overline{OUTB}$ Voltage (2V/Div), Bottom Trace: PWMB Voltage (2V/Div)

Conclusion

The LT3572 is a complete Piezo motor drive solution with a built-in high efficiency internal switch and integrated dual full-bridge drivers. Its fixed frequency, soft-start function, internal compensation and small footprint make the LT3572 a very simple and small solution to drive Piezo motors.

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