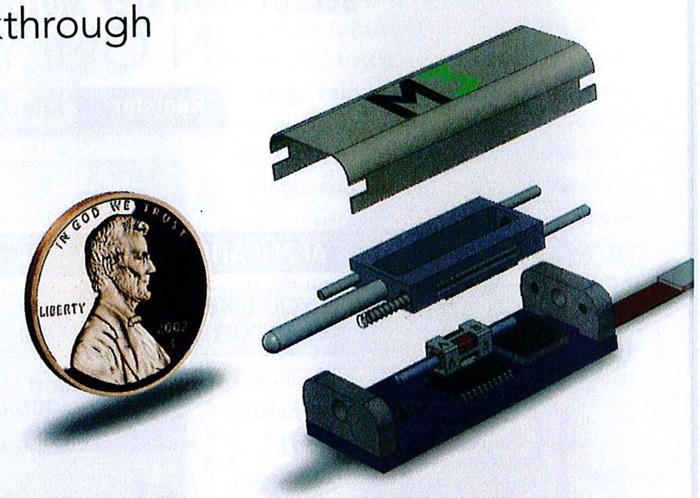
LOW POWER *PIEZO MOTION*

Reduced-voltage piezo motor breakthrough creates options for medical devices

BY AL PRESHER, CONTRIBUTING EDITOR



SOURCE: NEW SCALE TECHNOLOGIES

With New Scale's M3 linear design platform, a board-mounted SQUIGGLE RV micro motor is placed on a printed circuit board with a position sensor, drive ASIC and microprocessor. This base design can be customized for each OEM's mechanical configuration and input interface.

Dramatic reductions in voltage and power requirements are making tiny piezo motors and drive systems an interesting option for portable, low-power medical devices. By eliminating the need for the high voltage normally associated with piezo systems, a new piezo motor design from New Scale Technologies enables miniature motion systems that operate on a single 3-V battery without using voltage boost circuits.

"Normally piezo technology requires input of 40 volts or more, which is a concern especially in medical applications," says Ralph Weber, product manager for New Scale. Even though their previous systems and ASIC could run on a 3.3-V input, Weber says that the boost circuits to produce the higher input voltage required by all piezoelectric motors can scare designers.

"This is a breakthrough because using multi-layer ceramic technology, the system doesn't need 40 volts to operate," he says. "There is no aspect of the system which is high voltage anymore, and our approach also enables the drive chip and control circuitry to be reduced to very small sizes."

Piezoelectric micro motors are small enough for use in portable, handheld and implantable medical devices. The technology allows engineers to add motion where traditional electromagnetic motors would be impractical due to size and power limitations. Applications include positioning devices that can be adjusted after being implanted and robotic surgical tools. Special non-magnetic versions can also be designed to operate near MRI equipment without affecting image quality or motor performance.

Piezoelectric materials produce a stress or strain when electrically excited, yielding a few micrometers of motion with very low force. Piezoelectric motor designs harness ultrasonic vibrations of these actuators with a mechanical coupling to produce many millimeters of travel and high force, while retaining the benefit of sub-micrometer resolution.

Weber says the smallest commercially available piezo motor is New Scale's SQUIGGLE micro motor, a linear motor measuring less than 2.8 x 2.8 x 6 mm. Using a patented design, four piezoelectric plates are bonded to the sides of a rectangular tube which is threaded on the inside. A two-phase drive voltage applied to the plates causes the nut to vibrate in an orbital motion at its resonant (ultrasonic) frequency. Friction engages the threaded screw and drives it forward. Reversing the phase reverses the screw direction. The micro motor produces a smooth linear motion with no gears. Weighing only 0.16 gm, it can produce up to 50 gm of force, a variable speed of up to several millimeters per second and a position resolution of 0.5 micrometer.

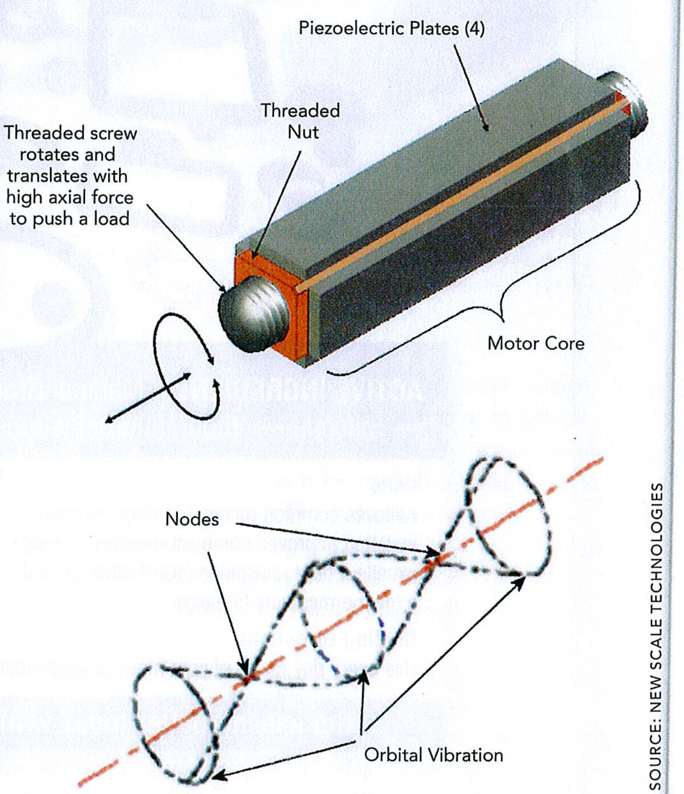
Like most piezo motors, Weber says the first SQUIGGLE motors employed "hard" PZT ceramic plates to minimize dielectric losses and associated temperature rise. Unfortunately this material requires an applied voltage of around 40V, requiring boost circuits in battery-powered applications. A breakthrough in PZT ceramic production has reduced this voltage requirement to 2.8V, making these tiny piezo motors even more appealing to designers of portable and handheld medical devices.

To achieve this breakthrough, New Scale collaborated with TDK-EPC on an advanced multi-layer piezo ceramic plate. The patent-pending plate is a co-fired assembly consisting of many thin layers of hard piezo ceramic, and each layer is less than 15 micrometers thick.

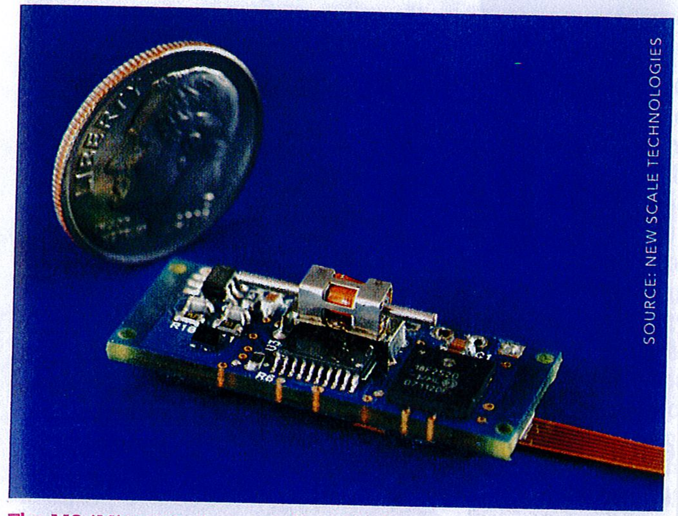
The new plate design has enabled the introduction of a new, reduced-voltage SQUIGGLE RV micro motor, which operates directly from a battery at less than 2.8V without boost circuits. Weber says this milestone is significant because it is the first piezoelectric motor to match the voltage requirements of traditional electromagnetic voice coil, dc and stepper motors. It removes the perception of risk associated with higher-voltage boost circuits and interconnections, and also enables radically smaller drive electronics by eliminating the need for boost circuits in the drive ASIC, as well as external inductors, capacitors and diodes.

Additional power-saving technology designed into the new drive ASIC for the SQUIGGLE RV produces the ultrasonic voltage signals that drive the motor. The NSD-2101 drive IC was developed in conjunction with New Scale's partner, austriamicrosystems. It incorporates patent-pending smart drive technology that monitors motor performance and adjusts the ultrasonic drive frequency to lock on to the mechanical resonant frequency of the motor.

Because of the motor's self-locking design, no power is needed to hold the motor position. A practical application is for periodic adjustment of an implanted device because the motor can be powered on to make the adjustment and then switched off entirely, drawing no battery power until the next adjustment is needed.



SQUIGGLE micro motor technology uses four piezoelectric plates bonded to the sides of a rectangular tube which is threaded on the inside. Two-phase drive voltage causes the nut to vibrate in an orbital motion at its resonant (ultrasonic) frequency. Friction engages the threaded screw to drive it forward; reversing the phase reverses the screw direction. See a computer simulation of SQUIGGLE motor operation at www.newscaletech.com/squiggle_overview.html.



The M3 (Micro-Mechatronic Module) design platform combines a SQUIGGLE RV motor, position sensor, the drive ASIC and a microprocessor in a miniature, closed-loop motion assembly.

The voltage reduction and the corresponding shrinking of the drive electronics enable a new class of integrated micro motion modules. The M3 (Micro-Mechatronic Module) design platform combines a SQUIGGLE RV motor, a position sensor, the drive ASIC and a microprocessor in a miniature, closed-loop motion assembly.

A TRACKER position sensor provides closed-loop feedback with resolution of 0.5 micrometers and repeatability of 2 micrometers. The onboard microprocessor provides PID control in the module. Input to the module can be configured for I2C, SPI or USART, and simple, serial communications from a PC or master microprocessor can command this miniature advanced motion control system.

The mechanical assembly and housing are customized to OEM specifications. The reference design contains all components and control electronics in a compact 12- x 30- x 8-mm package, with an actuator arm that travels up to 6 mm to push an external load.

Another reference design incorporates these advanced M3 platform controls into a miniature lens module, creating precise autofocus capabilities in a package only slightly larger than the lens holder for board-mounted camera systems.

Using this platform, modules can be developed for nearly any configuration or application. They can also be sealed for use in high-moisture applications or implantable devices.

For more information:

- *New Scale: http://designnews.hotims.com/27746-503*
- *TDK-EPC: http://designnews.hotims.com/27746-504*
- *austriamicrosystems: http://designnews.hotims.com/27746-505*