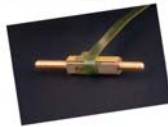




The big breakthrough in making smaller products.

Tiny piezoelectric SQUIGGLE motors are driving dramatic size reductions **and** performance gains in next-generation electronic products. With its small size and low power draw, this amazing new technology sets in motion a whole new world of ideas.



What could you do with a motor this small?
 SQL Series SQUIGGLE motor shown actual size
 US patent numbers 6,940,209; 7,170,214; 7,309,943

Breaking the motor miniaturization barrier

Electromagnetic motors have reached their limit of miniaturization. These complex devices have hundreds of parts, and below about six millimeters in diameter their efficiency drops sharply. More power is wasted as heat, less torque is produced to overcome internal friction, and reliability and efficiency degrade.

MEMS techniques are producing nanometer-scale micro-motors, but these futuristic devices are limited to microscopic push force and travel range. Product designers need a new motor technology today – smaller than traditional motors but larger than MEMS – to create motion and add new features in smaller and smaller products.

Tiny size and low power draw

Tiny SQUIGGLE motors are the answer. An entirely new motor technology platform, this patented ultrasonic actuator features high efficiency at extremely small sizes (less than 2 mm). It holds position with the power off, further maximizing battery life.

SQUIGGLE motors and micro-actuator modules offer high force, high speed, sub-micrometer precision and millimeters of stroke. With excellent shock tolerance and wide operating temperature range, they are ideal for mobile battery-powered devices including phone cameras, electronic locks, medical instruments, and more.

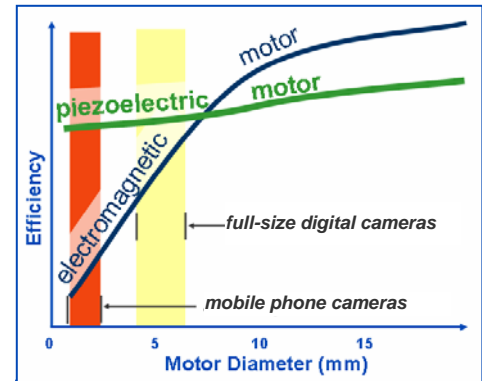
The world's smallest linear motor

The award-winning SQUIGGLE motor is a simple and elegant design with only seven parts, suited to high-volume manufacturing at low unit cost. The smallest SQUIGGLE motor has half the size and ten times the resolution and push force of competing piezoelectric motors.



APPLICATIONS

- Imaging – auto focus & zoom**
phone cameras, imagers, endoscopes
- Locks & fasteners**
automotive, security, biometric access
- Fluid control & micro-fluidics**
drug pumps, micro fuel cells, lab-on-a-chip
- Micro-actuators**
automotive, MRI-compatible instruments, toys, UAVs
- Precision alignment**
medical, industrial, optics, lasers, research, aerospace and defense



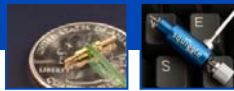
PIEZOELECTRIC MOTORS are more efficient than electromagnetic motors at the tiny sizes needed for devices such as phone cameras.



SQUIGGLE MOTORS are scalable down to millimeters in size. With this technology platform we create motors and application-specific modules that enable our OEM partners to realize next-generation product ideas today.



USING SQUIGGLE MOTORS



How they work

A SQUIGGLE motor is basically a threaded nut and screw. Two-phase drive signals cause piezoelectric actuators to vibrate the nut at a fixed resonant frequency. The nut vibrates in a “hula hoop” motion that causes the screw to rotate and translate with sub-micrometer precision.

The screw translation is bi-directional, and the position of the tip of the screw is precisely controlled by the driver. Speed is variable from micrometers per second to millimeters per second. When combined with a position sensor in a closed-loop system, the SQUIGGLE motor can deliver position repeatability in microns or nanometers.

This patented design has high shock resistance, as the piezoelectric ceramics are isolated from the load. At zero power the vibration stops and the threads hold the screw in position with very high stiffness and stability. This “off-power hold” preserves battery life in portable devices.

Specifying a SQUIGGLE motor

For OEM use, we work with your product design team to create a SQUIGGLE motor or application-specific module to meet your exact needs. We help you navigate the trade-offs among size, speed, force, resolution and power; evaluate closed-loop control options; and design integrated modules or motor mounts to fit your system.

Motor controller cards allow easy evaluation of SQUIGGLE motors and modules, and serve as reference designs for your own drive circuits. ASIC motor drivers are in development.

For research and laboratory use, we offer several standard motors including vacuum, cryogenic and non-magnetic models. Drive cards and benchtop controllers include PC software with ActiveX command library.

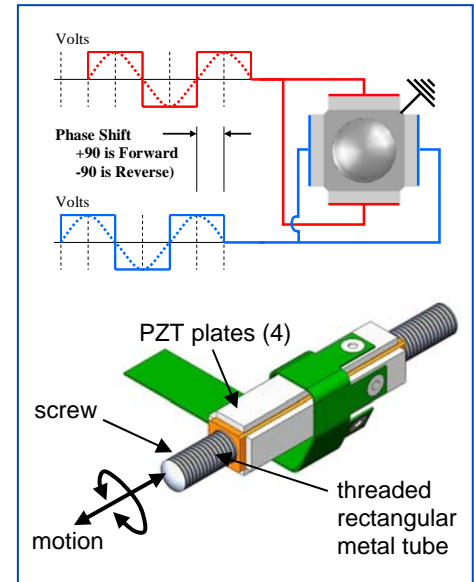
Complete motion systems

Partnership with *austriamicrosystems* enables New Scale to produce complete closed-loop motion systems that incorporate micro motors and supporting electronics (ASICs) in extremely small modules, ready for integration into OEM products.

Range of capabilities

	Size * (mm)	speed (mm/s) ½ max load	force (N) max load	Reso- lution	Travel (mm)
We work with you to create motors & modules and integrate them into your OEM systems. This table illustrates our range of capabilities.					
SQL series motors	1.5 x 1.5 x 6	5	0.2	0.5 µm	6
	1.8 x 1.8 x 6	5	0.2		6
	3.4 x 3.4 x 10	5	2		20
SQ-100 series motors	∅ 7.4 x 12.5	2	5	20-50 nm	50
	∅ 12.3 x 36.6	2	5		50
SQL-M series modules	13.5 x 4.2 x 4.3	7	0.3	n/a	3
	17.5 x 6.5 x 7.0	4	2		4

* Length of housing. Overall length determined by motor screw (i.e. travel range).



ULTRASONIC SQUIGGLE MOTOR is driven by a two-channel sinusoidal or square wave at an ultrasonic frequency of 40 kHz to 200 kHz, matching the first bending resonant frequency of the threaded tube. This creates an orbital motion which drives the screw.



Closed-loop controller for 2 motors

DRIVE ELECTRONICS include benchtop and PCB models, as well as ASIC-ready reference designs for OEMs. Control SQUIGGLE motors with analog input, or via computer using the ActiveX command library provided.

MARKETS



SQUIGGLE motors enable smaller products in markets including:

- Mobile phone cameras
- Electronic access control
- Automotive modules
- Medical devices
- Consumer electronics
- Industrial, research, aerospace and defense

APPLICATIONS

IMAGING

Tiny focus and zoom assemblies yield better images

The SQUIGGLE motor offers short-range motion for auto focus and long-range motion for optical zoom. SQUIGGLE focus and zoom modules enable drastic improvements in image quality for 3MP, 5MP and even 8MP phone cameras, delivering picture quality which rivals that of high-end digital still cameras while meeting the size and power constraints of mobile phone handsets.

We have several reference designs for the **phone camera market**. An auto focus module in a SMIA85 package uses a SQUIGGLE motor to move a lens in a flexure mount. An auto focus plus 3x optical zoom module has two lens groups mounted on rails for smooth motion, driven by two SQUIGGLE motors with position sensors for closed-loop control.

Other imaging applications include focus, zoom and alignment in:

- Cryogenic sensors, such as hyperspectral and infrared imagers
- Tiny cameras for biometric ID systems
- Medical and industrial endoscopes
- Night vision systems

ELECTRONIC LOCKS and FASTENERS

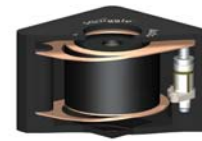
Low power, high performance for security

SQUIGGLE motors enable more compact modules with lower power requirements for electronic lock and intelligent fastener applications. The SQUIGGLE screw directly pushes the load without the need for sliders and guide bearings, and remains solidly in place with the power off. "Drop in" modules are available.

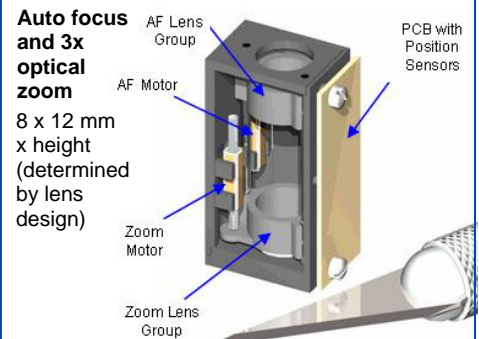
SQUIGGLE motors offer significant advantages over older technologies used in this application. Compared to shape memory alloys, SQUIGGLE motors have much longer stroke, faster response time, more accurate position control, and wider operating temperature range. Compared to solenoids, SQUIGGLE motors have dramatically smaller size, lower power usage, bi-directional travel and more accurate position control.

FEATURES

- Scalable to tiny sizes < 2mm
- Low power usage
- Off-power position hold
- High push force
- Long travel
- Variable speed to millimeters/sec
- Sub-micrometer precision
- Direct linear movement, no gears *reduces part count in OEM product*
- Withstands high shock
- Operating temperature -30° to +80°C

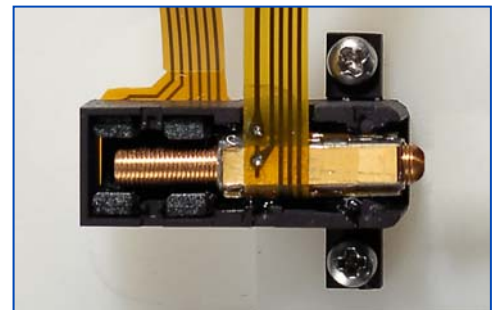


Auto focus
8.5 x 8.5
x 6.1 mm
(SMIA85)



MODULES FOR PHONE CAMERAS

include a thin SMIA85 auto focus module and an auto focus / 3x zoom module.



MICRO-ACTUATOR MODULE for electronic locks and latches incorporates a SQUIGGLE motor with limit switches in a compact polymer housing (shown with cover removed).

APPLICATIONS (continued)

FLUID CONTROL and MICRO-FLUIDICS

Precision pumps and valves for wide-ranging applications

Fluid control applications of the SQUIGGLE motor include:

- Medical syringe pumps
- Wearable and implantable drug pumps
- Micro-pumps, valves and switches
- Micro fuel cells
- Lab-on-a-chip systems
- Computer chip cooling
- Spacecraft propulsion systems

SQUIGGLE motors are useful for MRI-compatible syringe pumps and smaller, more accurate drug pumps. They have been demonstrated to drive a 1cc syringe connected to a PE 50 catheter (< 50 cm in total length) at a controlled speed of about 1 mm/sec (0.0185 cc/sec).

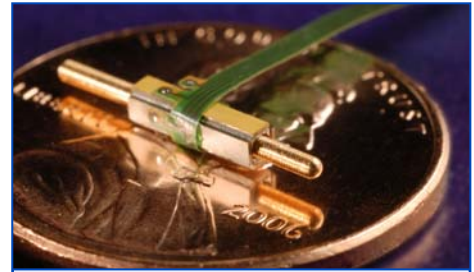
A design concept for a positive displacement micro-pump uses SQUIGGLE motors to move small quantities of fluids with nanoliter precision. Much smaller than today's oscillating membrane pumps, this design also offers greater precision, higher output pressure, steadier flow rates, and ability to move fluids with particles and air bubbles.

MICRO-ACTUATION and PRECISION ALIGNMENT

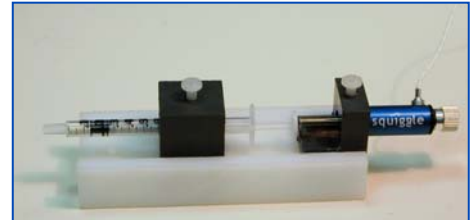
Automotive, consumer, industrial, research, aerospace and defense

SQUIGGLE motors are used for micro-actuation and precision alignment in a wide range of additional applications. These include:

- Unmanned aerial vehicles (UAVs)
- MRI-compatible instruments
- Positioning in cryostats for research and instrumentation
- Automated alignment of optics and laser systems
- Microscopy applications including scanning electron (SEM) and focused ion beam (FIB) microscopy

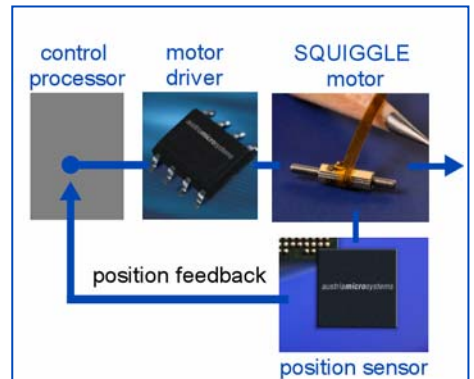


WORLD'S SMALLEST LINEAR MOTOR has low power use, high force, long travel and sub-micrometer precision. Speed is continuously variable to millimeters per second.



SQUIGGLE SYRINGE PUMP used in the bore of the magnet provides precise contrast media delivery during MRI data acquisition.

Photo: Roswell Park Cancer Center



COMPLETE MICRO-MOTION SYSTEMS from New Scale, created in partnership with austriamicrosystems.

About New Scale Technologies, Inc.

New Scale creates disruptively small motion systems based on our patented piezoelectric SQUIGGLE® motor, the world's smallest linear motor. This ultrasonic motor is smaller, more precise, less expensive, more robust and more power-efficient than other micro motors. We create complete motion systems integrating SQUIGGLE motor technology with supporting electronics (ASICs) developed in partnership with austriamicrosystems.

New Scale's micro motors and micro-actuator modules enable design engineers to create smaller products including mobile phone cameras, electronic locks and intelligent fasteners, nano-scale fluid control including lab-on-a-chip systems, medical devices including miniature drug pumps and endoscopes, optics and imaging systems, automotive modules, lasers, aerospace and defense systems, cryogenic and MRI-compatible instruments, and consumer electronics including micro fuel cells.

