New Scale Technologies

TECHNICAL BULLETIN
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SQL-RV Series SQUIGGLE®[1] Motors Reduced Voltage Linear Motor and Drives

New Scale creates small, precise and smart motion systems. Many of our motor products are based on our patented and proprietary SQUIGGLE® RV "reduced voltage" piezoelectric ultrasonic motors and drive circuits.

This technical bulletin describes the performance of the miniature SQL-RV SQUIGGL motors and drives. These include the SQL-RV-1.8 and SQL-RV-3.4 motors, the NSD-2101 driver ASIC (Figure 1), and multi-chip drive circuits. All items incorporate New Scale's patented and proprietary technologies and know-how.

New Scale's standard business practice is to integrate these devices into our M3 Micro-Mechatronic Modules with position sensors, guide mechanisms, and microprocessor with embedded closed-loop firmware. Please contact us about standard and custom M3 motion modules.

SQUIGGLE motors and drivers are only sold as separate components to qualified customers with significant order quantities and parallel business agreements that may include customization fees and licensing and technology transfer agreements.

Reduced Voltage is a New Paradigm

Using co-fired multi-layer piezoelectric materials creates a new paradigm for piezoelectric ultrasonic motors that operate directly from common battery sources. The multi-layer internal structure multiples the electric field applied and corresponding induced piezoelectric strain. Each active piezo element has isolated grounds that enables bi-polar full-bridge switching at the motor operating frequency. The result is an effective doubling of the input voltage acting on each piezoelectric layer.

Previous generations of piezo motors require 100's of volts to operate which multiplied system complexity and size. Higher voltage (HV) requires special and larger cables and connectors for safety and isolation. HV driver circuits require special components, transformers and HV power supplies. The result was HV electronics that are at least ten times larger and heavier than the piezo motor.

Reduced voltage (RV) piezo motors typically operate from 3.3 to 6 volts and use the smallest cables and connectors. No internal voltage boost is required; standard CMOS integrated circuits are well suited to create lower voltage waveforms with higher current.

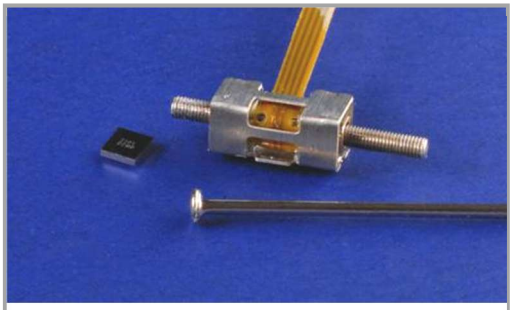


Figure 1: SQL-RV-1.8 SQUIGGLE motor with NSD-2101 piezo motor driver shown next to a common pin.

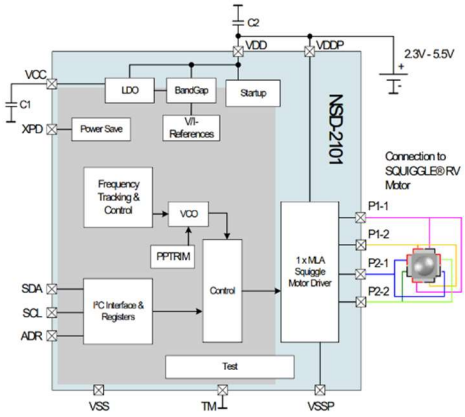


Figure 2: NSD-2101 Smart IC provides advanced piezo control circuitry in a 1.8mm x 1.8mm package. The data sheet for this ASIC is found at https://newscaletech.com/wp-content/uploads/NSD-2101-datasheet-ams.pdf

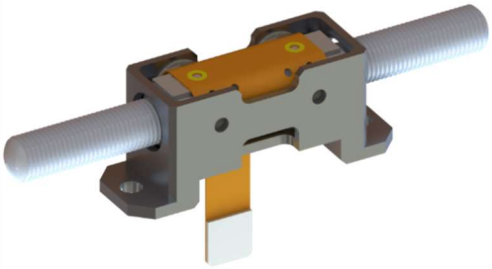


Figure 3: SQL-RV-3.4-15 SQUIGGLE Motor with 15mm of travel Custom lengths of FPC are available Variants with different screw lengths are possible

[1] SQUIGGLE motor is a registered trademark of New Scale Technologies.

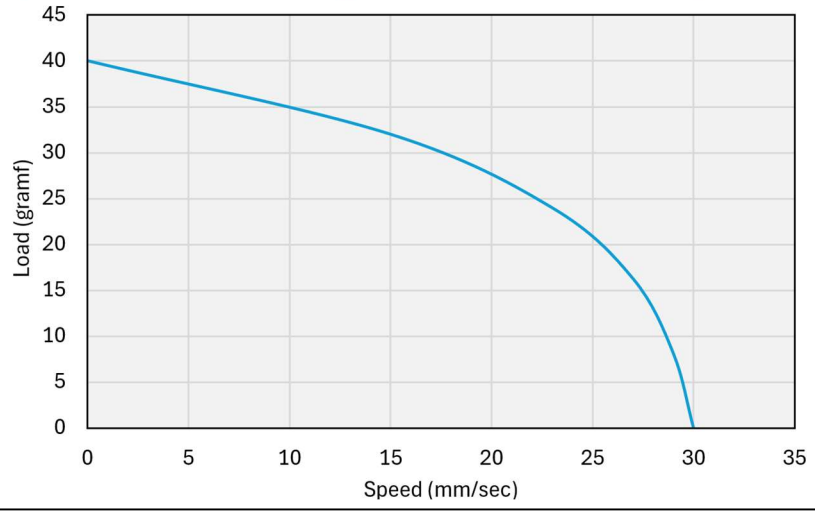
Highest Force, Smallest Size, Sub-Micrometer Precision, Off-Power Hold

Squiggle motors are constructed from a threaded screw and nut. Piezoelectric plates are part of the nut and electrically driven to ultrasonically vibrate the nut which causes the screw to rotate and translate. The unique screw design of this ultrasonic motor achieves very high force is a small size. The fine-pitched threads reduce speed and multiply precision with inherent off-power holding force.

Optimized Drives

The performance of each Squiggle RV motor is linked to New Scale's patented and proprietary driver solutions. These drive solutions include the NSD-2101 driver ASIC and multi-chip drive circuits. All solution incorporate special features to minimize operating power and optimize velocity and position control.

Figure 4: SQL-RV-1.8 Motor Typical Performance with 3.3V input

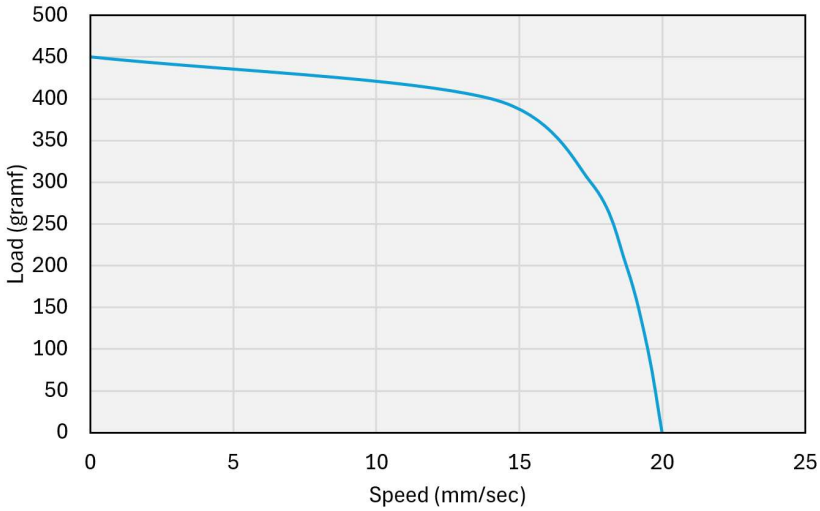


Customized system performance

New Scale develops custom motors and smart motion modules for qualified customers. In each development project, we guide OEM customers through system performance trade-offs including force, power, speed, precision, size and lifetime.

We deliver integrated and optimized motion solutions to meet each customer's needs.

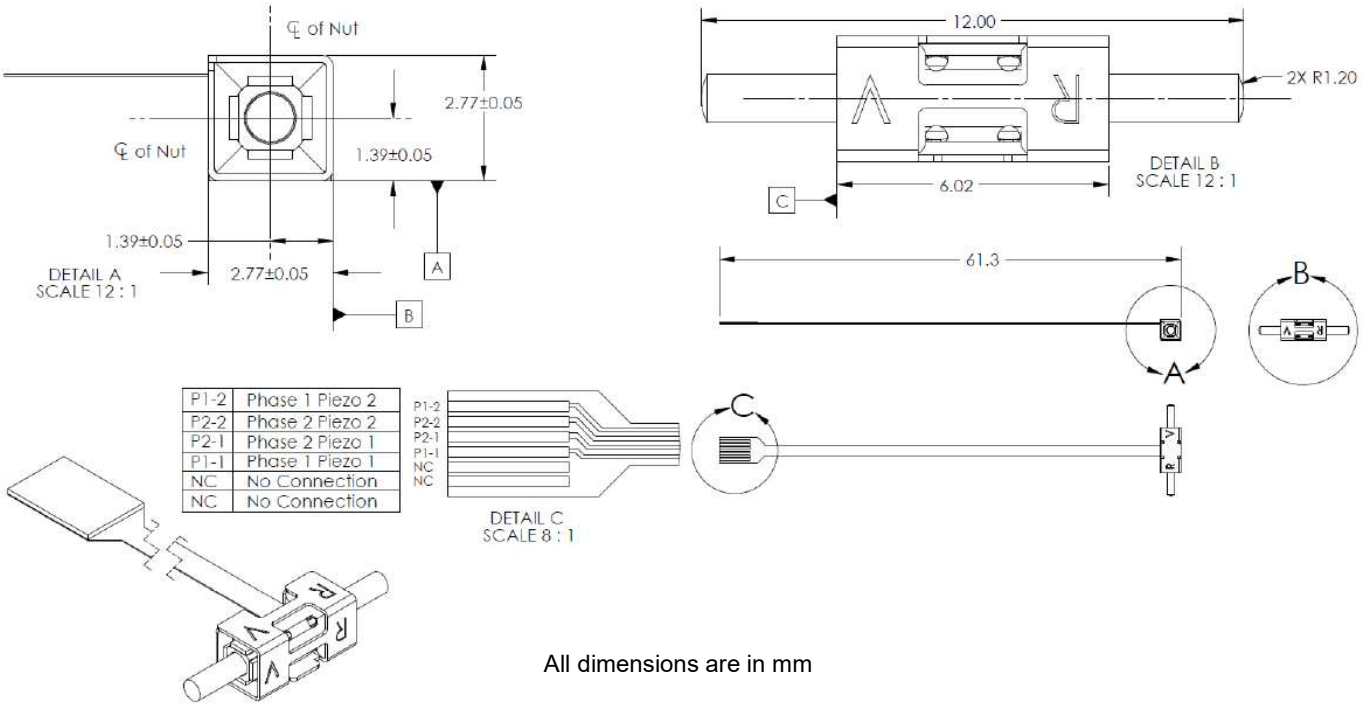
Figure 5: SQL-RV-3.4 Motor Typical Performance with 6V input



SQL-RV motor and controller performance		
	SQL-RV-1.8 motor with NSD-2101 ASIC	**SQL-RV-3.4-15 with multi-chip driver circuit**
Travel Range	6 mm | others available	15 mm | others available
Housing Dimensions	2.8 x 2.8 x 6 mm	4.75 x 4.5 x 11.2 (Excluding mounting feet)
Stator Dimensions	1.8 x 1.8 x 6 mm	3.4 X.3.4 X 10 mm
Stall Force	0.3 N (3.3V input)	3 N (6V input)
Speed	> 10 mm/s (25 gram load)	> 7 mm/s (250 gram load)
Resolution	< 0.5 µm	< 0.5 µm
Input Power (stopped)	OFF POWER HOLD (0 mW)	
Typical Input Power to motor driver * (Closed loop)	1 W @ 3.3V, 5mm/s with 10 gram load	5 W @ 6V, 4mm/s with 100 gram load (Direct Drive)
Input Power to controller componen (idle power)	~270 mW (MC-33MB controller) ~30 mW (MC-33DB-RV)	~270 mW (MC-33MB controller)
Lifetime	>1 Million cycles (15 gram force load at 7mm/s)	> 300k cycles (1 N vertical load at 4mm/s)
Operating Temperature	-30 to +80° C	
Storage Temperature	-40 to +85° C	
Operating Frequency	~ 175 KHz	117 KHz
Motor Controller	NSD-2101 Driver IC (qty 2)	DRV8837 TI (qty 2)
Weight	0.16 grams	1.1 grams

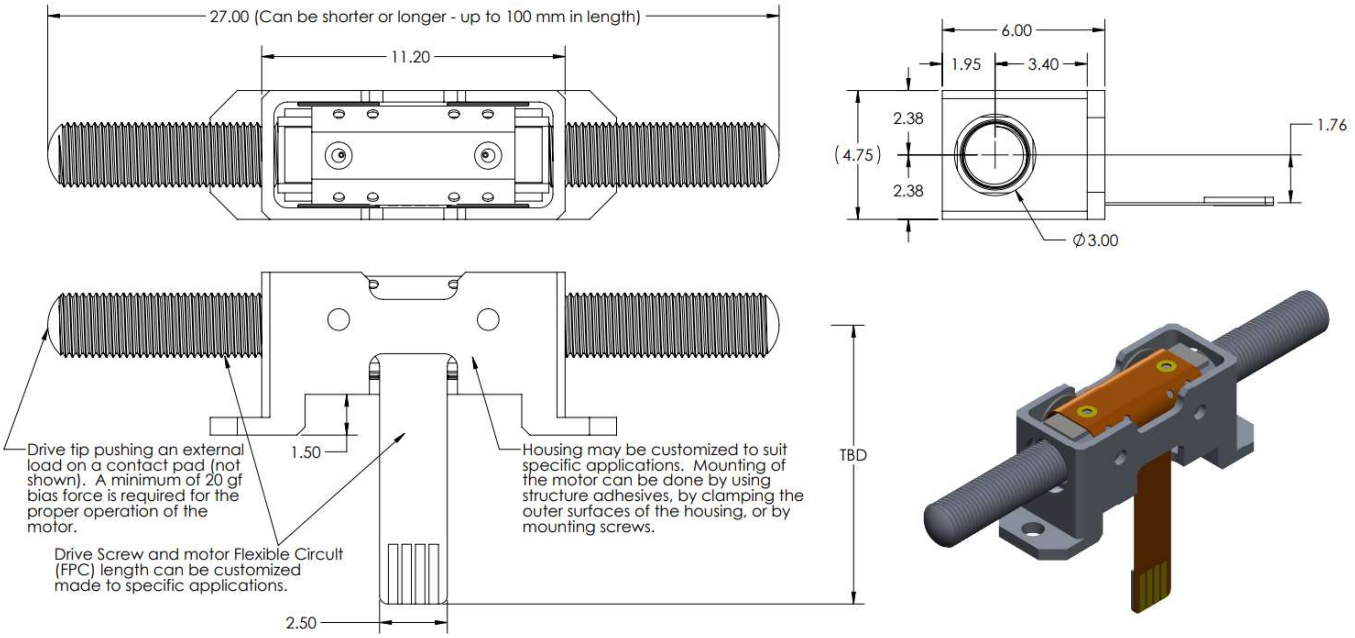
* Power depends on input voltage, speed & load.

Figure 6: SQL-RV-1.8-6 SQUIGGLE motor dimensions



All dimensions are in mm

Figure 7: SQL-RV-3.4-15 SQUIGGLE motor dimensions



M3 Modules and Developer's Kits

Each Developer's Kit includes our New Scale Pathway™ software (Figure 8) for PC control. This flexible and sophisticated tool enables rapid evaluation of New Scale motion systems. An easy-to-use, "point and click" graphical user interface allows you to select tabs, enter values in boxes (speed, step, frequency, etc.) and click graphical buttons (jog, run, etc.) to control New Scale systems. All features are accessible using mouse and keyboard.

The software also features a powerful script generator that enables you to create and run automated commands and sequences for almost any motion control task. The script editor is fast, flexible and easy to use, even by non-programmers.

Developer's kits demonstrate the performance of these integrated motion systems. Developer's Kits are available from select distributors.

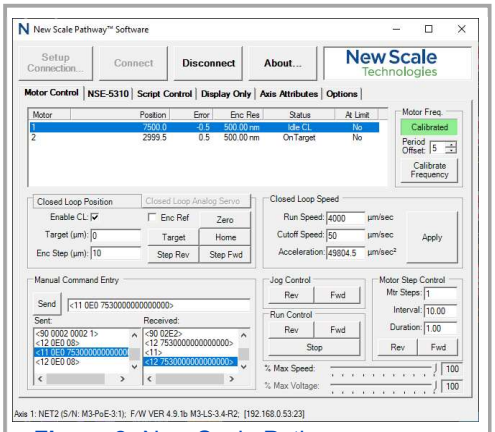


Figure 8: New Scale Pathway software facilitates evaluation of motors and M3 motion module motor performance and definition of system specifications.