

SQUIGGLE RV

SQL-RV-1.8 SQUIGGLE Reduced Voltage Linear Motor and Drive ASIC

New Scale creates small, precise and smart motion systems. Many of our systems are based on our patented SQUIGGLE® RV reduced voltage piezoelectric micro motor and NSD-2101 drive IC.

This technical bulletin describes the performance of the miniature SQL-1.8-RV motor and NSD-2101 drive ASIC (Figure 1).

We integrate these devices into our M3 Micro-Mechatronic Modules. *The SQUIGGLE motors and drivers are not sold as separate components.* Contact us about standard and custom motion modules we develop based on these devices.

The world's smallest linear motor gets smarter

The SQL-RV-1.8 SQUIGGLE motor is 2.8 x 2.8 x 6 mm with best-in-class speed, resolution and push force. The new reduced voltage (RV) version features state-of-the-art multi-layer piezo technology.

The NSD-2101 piezo motor driver is a compact motor drive ASIC only 1.8 x 1.8 mm in wafer-level form (Figure 2). It converts 2.3 to 5.5 VDC battery input directly to high frequency AC power to control the SQL-RV SQUIGGLE motor. This "smart IC" features advanced, proprietary features such as frequency tracking and hybrid speed control to optimize motor performance while minimizing power consumption over a broad range of operating and environmental conditions.

Together the motor and driver achieve a number of industry firsts:

- Direct battery input as low as 2.3 VDC to the drive chip with no external voltage boost circuitry required.
- Complete driver solution much smaller than the motor and 5x smaller than comparable systems.
- 40% lower power use than comparable electromagnetic solutions.

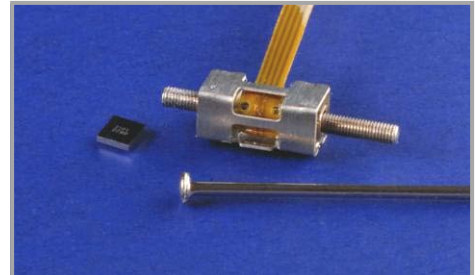


Figure 1: SQL-RV SQUIGGLE motor with NSD-2101 piezo motor driver shown next to a common pin.

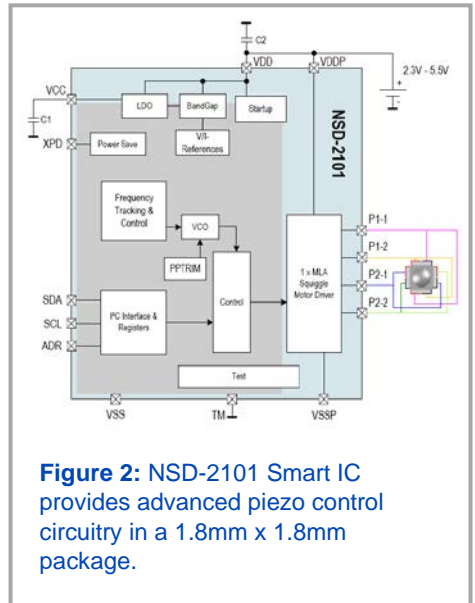


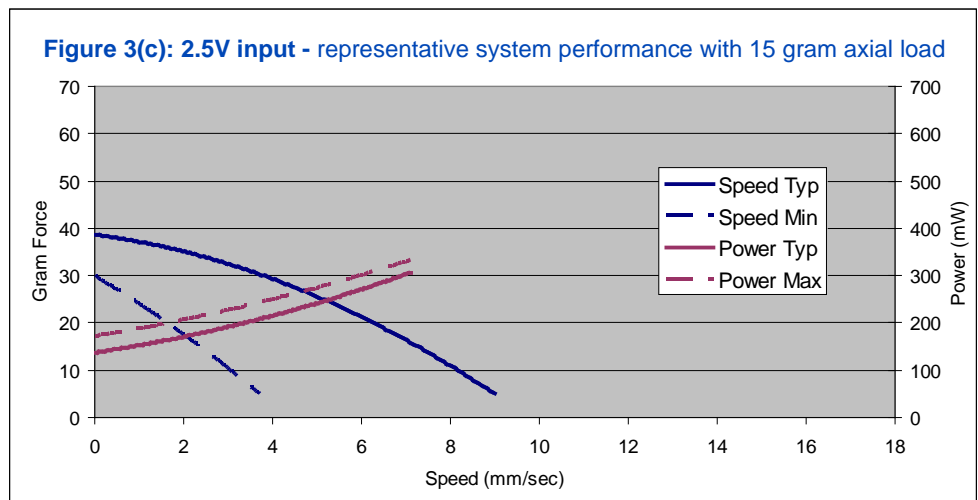
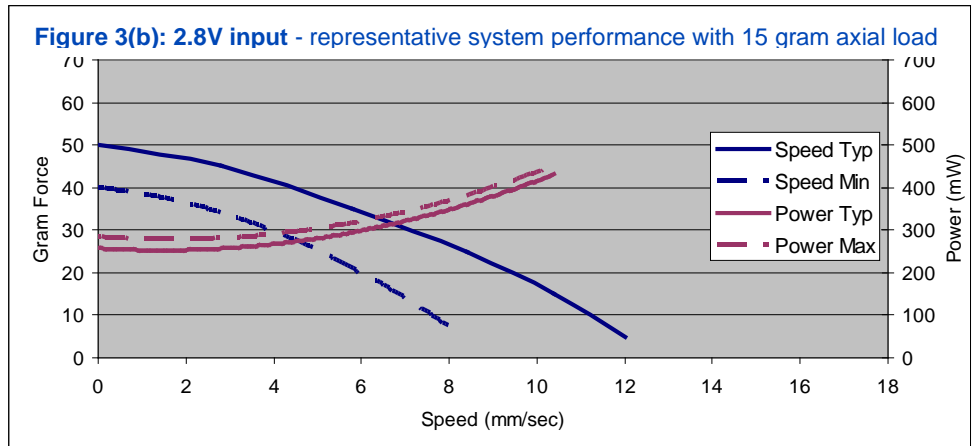
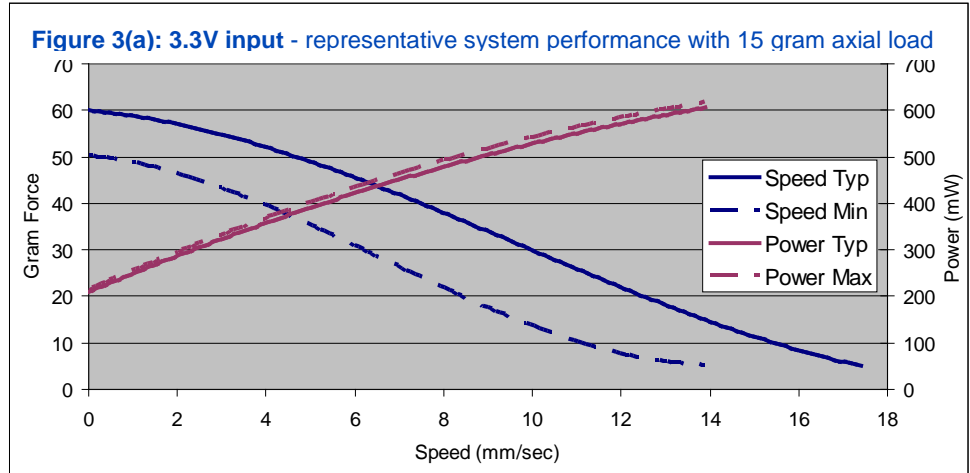
Figure 2: NSD-2101 Smart IC provides advanced piezo control circuitry in a 1.8mm x 1.8mm package.

Unmatched size and performance

The graphs (Figure 3) show typical force and speed of SQL-RV-1.8 motors for different input voltage to the NSD-2101 IC. Also shown is the power required at these voltages to achieve a range of linear motor speeds. These illustrative curves are generated with a 15 gram of axial load applied to the motor.

Customized system performance

New Scale develops custom smart motion systems using the SQL-RV-1.8 and NSD-2101 components. In each development project, we guide OEM customers through system performance trade-offs including force, power, speed, size and lifetime. **We deliver integrated motion solutions to meet each customer's needs.**



System performance

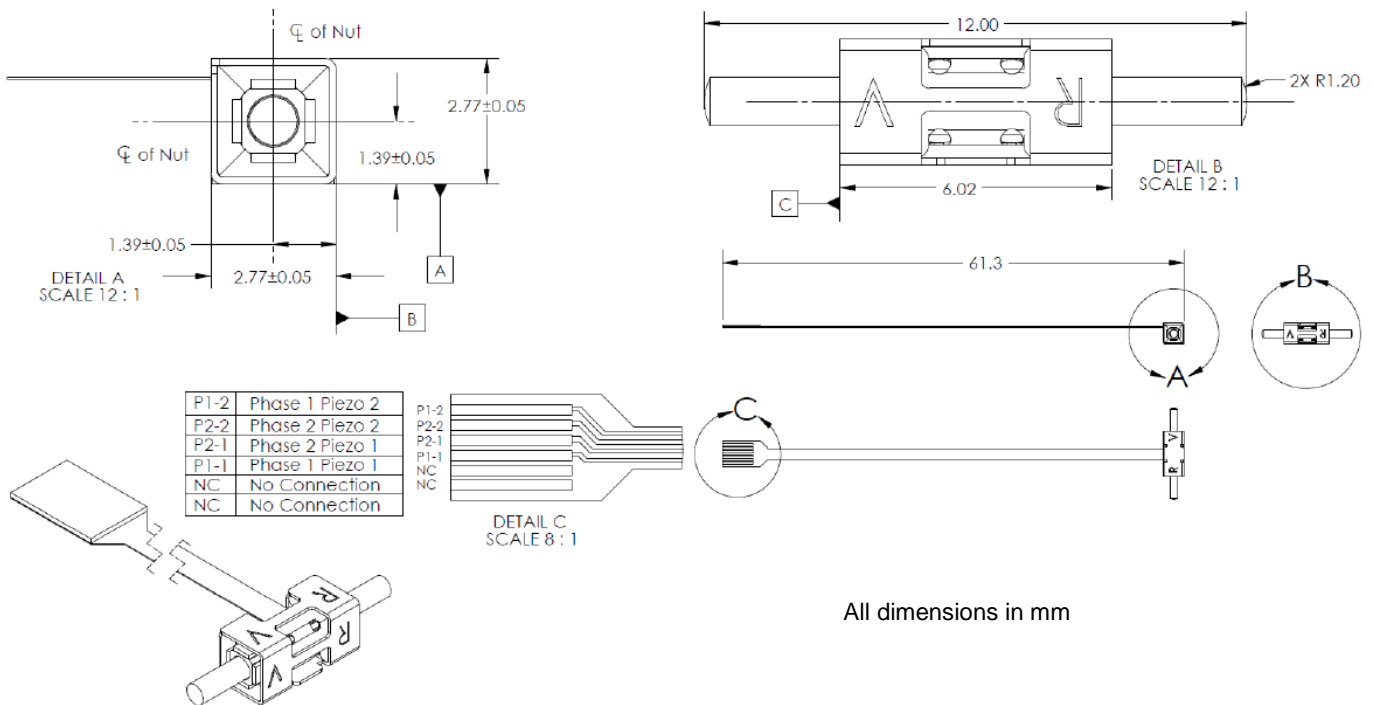
The table shows typical performance for the SQUIGGLE RV motor and drive system. The integrated solution provides high force, speed, efficiency and resolution with robust long-term performance.

NSD-2101 motor driver IC	
Input Power	2.3 to 5.5 V DC
Output Signals	ONE set of 4 high frequency half-bridge control signals providing control for ONE SQL-RV-1.8 motor (+P1-1, -P1-2, +P2-1, -P2-2)
Control Input	I ² C serial interface
Additional specifications	See detailed NSD-2101 data sheet
Dimensions (l x w x h)	1.8 x 1.8 x 0.6 mm ball grid array chip scale package or 4 x 4 x 0.9 mm 16-pin QFN

SQL-RV-1.8 motor and controller performance	
Travel Range	6 mm others available
Housing Dimensions	2.8 x 2.8 x 6 mm
Stator Dimensions	1.8 x 1.8 x 6 mm
Stall Force (3.3V input)	30 gram force // 0.33 N
Speed (at 15 gram load)	> 7 mm/s
Resolution	0.5 μm
Input Power (stopped)	OFF POWER HOLD (0 mW)
Input Power to motor driver (moving) *	< 340 mW (direct drive)
Input Power to controller components (idle power)	< 1 mW (MC-33DB-RV) ~330 mW (MC-33MB controller)
Lifetime **	>1 Million cycles
Operating Temperature	-30 to +80° C
Storage Temperature	-40 to +85° C
Shock Resistance ***	2500 Gs
Operating Frequency	~ 171 KHz
Motor Controller	NSD-2101 Driver IC (qty 2)
Weight	0.16 grams

* Power depends on input voltage, speed & load. Shown at 15g load. Measured at 2.8V, 7mm/sec
 ** Continuous operation at full speed, room temperature, 15 gram force load.
 *** Motor Only - zero mass load.

Figure 4: SQL-RV-1.8 SQUIGGLE motor dimensions



Open-loop vs. closed-loop operation

The SQL-1.8-RV SQUIGGLE motor is an open-loop motor with 0.5 μm resolution. We use a linear sensor such as our NSE-5310 encoder for closed-loop operation when repeatable step size, absolute position or precise velocity control is needed. See the application note “M3 Modules and Closed-Loop vs. Open-Loop Stepping.”

(<https://www.newscaletech.com/tech-note-m3-modules-closed-loop-vs-open-loop/>)

M3 Modules and Developer’s Kits

M3 Module Developer’s Kits (Figure 5) allow engineers to evaluate our miniature closed loop motion systems.

Each Developer’s Kit includes our New Scale Pathway™ software (Figure 6) 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.

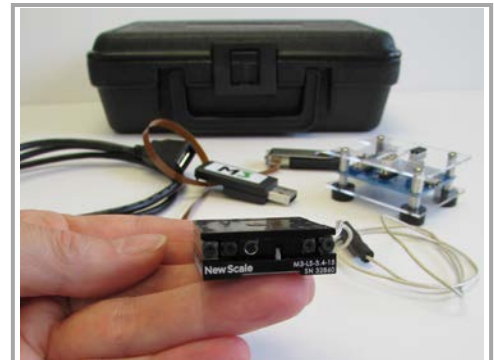


Figure 5: Developer’s Kit for an M3-LS Smart Stage. A SQUIGGLE RV motor, driver and encoder are all embedded in the compact microstage housing. The external breakout board housing is provided for development and testing.

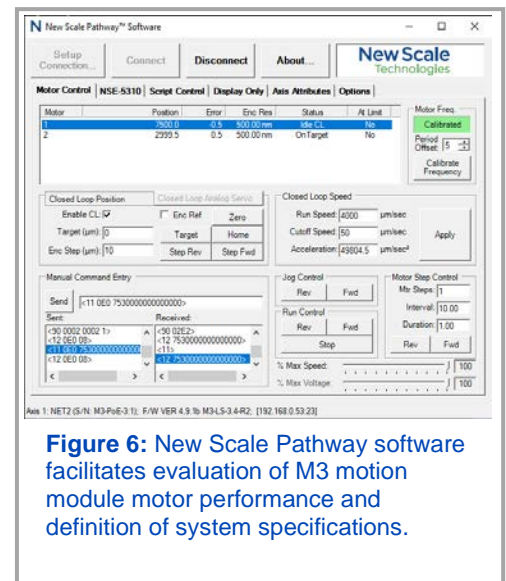


Figure 6: New Scale Pathway software facilitates evaluation of M3 motion module motor performance and definition of system specifications.