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. We integrate these innovative devices into our M3 smart modules, micro-mechatronic modules that deliver performance comparable to much larger systems.

This technical bulletin describes the performance of the miniature SQL-1.8-RV motor and NSD-2101 drive ASIC (Figure 1). Contact New Scale or visit our website for information about standard and custom motion modules we develop based on these tiny components.

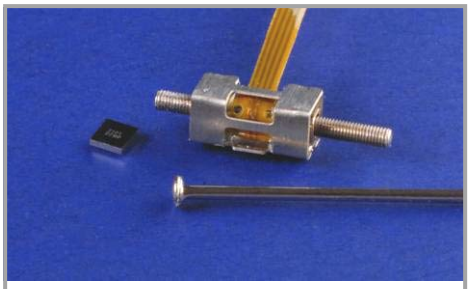


Figure 1: SQL-RV SQUIGGLE motor with NSD-2101 piezo motor driver shown next to a common pin.

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.

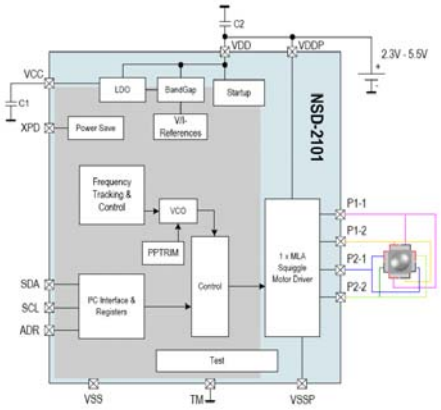


Figure 2: NSD-2101 Smart IC provides advanced piezo control circuitry in a 1.8mm x 1.8mm package.

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.

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.

Figure 3(a): 3.3V input - representative system performance with 15 gram axial load

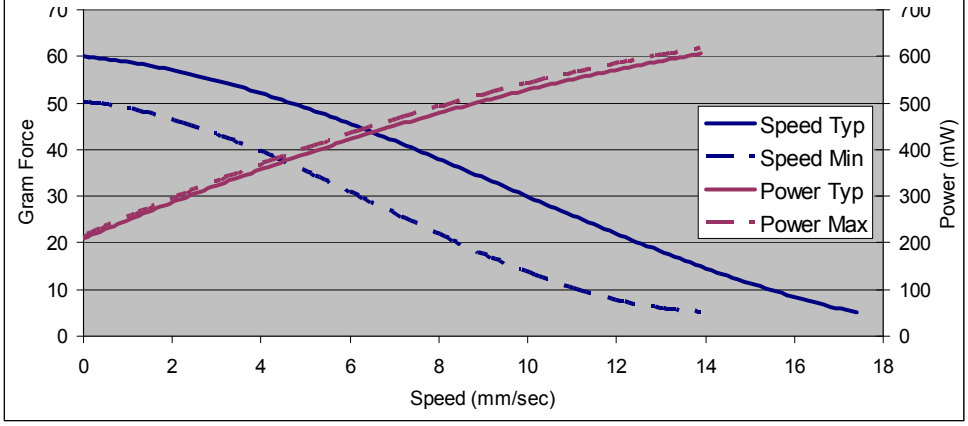


Figure 3(b): 2.8V input - representative system performance with 15 gram axial load

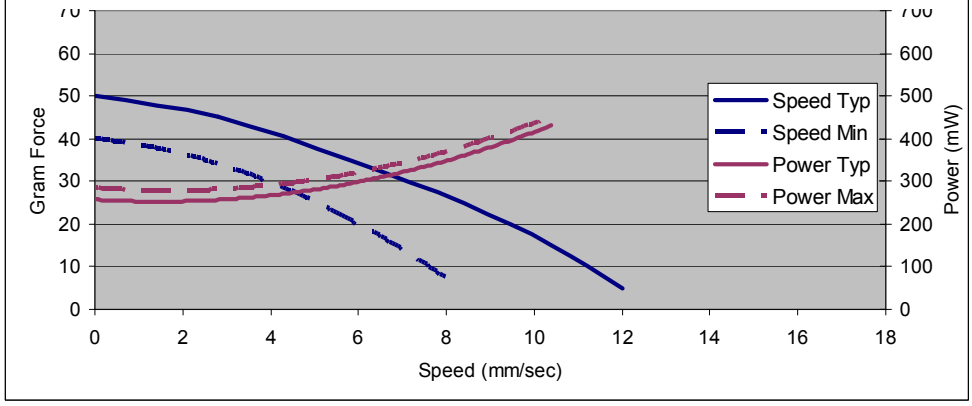
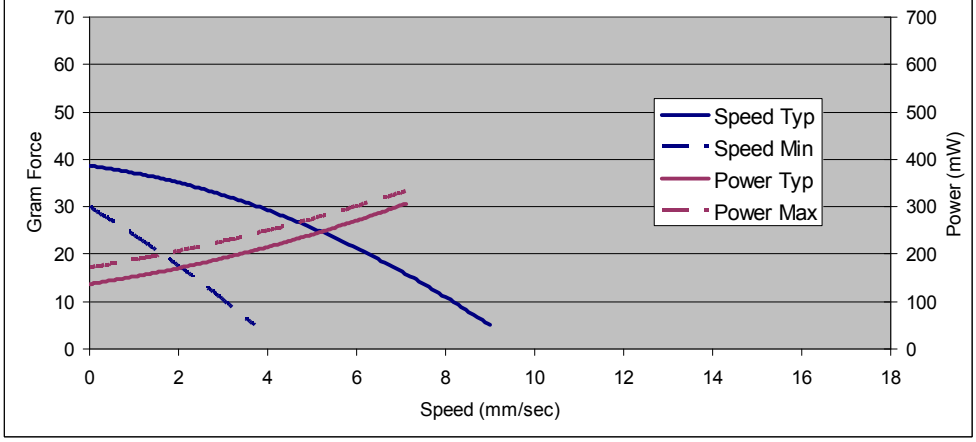


Figure 3(c): 2.5V input - representative system performance with 15 gram axial load



System performance

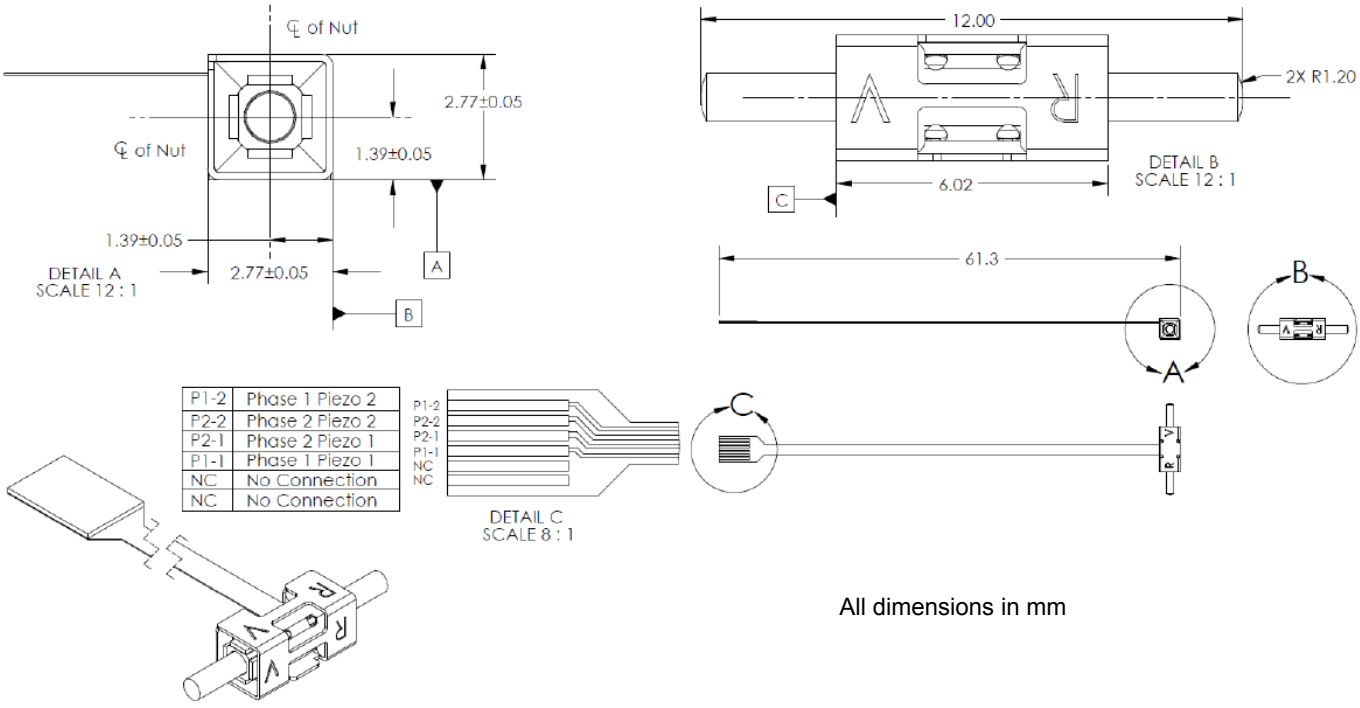
The table shows typical performance for the SQUIGGLE RV motor and drive system. The integrated solution provides high force, speed, efficiency and resolution with robust long-term performance.

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^2C 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



All dimensions in mm

Open-loop vs. closed-loop operation

The SQL-1.8-RV SQUIGGLE motor is an open-loop motor with 0.5 µm resolution. We recommend using a linear sensor such as New Scale's NSE-5310 encoder for closed-loop operation when repeatable step size, absolute position or precise velocity control is needed. See the application note *"Creating Closed-Loop Positioning Systems Using SQUIGGLE Motors."* (Online at www.newscaletech.com/application_notes.html)

Figure 5: SQL-RV-1.8 Developer's Kits are battery-operated, ready-to-use kits that include a motor, controller, position sensor (for closed-loop kits) and New Scale Pathway™ software.

SQL-RV SQUIGGLE motor Developer's Kits

(see Developer's Kit Datasheets for additional information)

The Developer's Kit (Figure 5) allows engineers to evaluate a tiny, closed loop motion system reference design with integrated SQUIGGLE RV micro motor, NSD-2101 piezo motor driver and NSE-5310 position sensor.

New Scale Pathway™ software (Figure 6) is included for PC control. This flexible and sophisticated tool enables rapid evaluation of New Scale motors, sensors and 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.

The developer's kit demonstrates the performance of these tiny components pre-mounted in an integrated motion system. It is designed to help engineers define system specifications for subsequent development of M3 Smart Modules or custom micro motion modules with New Scale Technologies.

Developer's Kits are available to qualified OEMs as part of a development program with New Scale, or for purchase from select distributors through ams.

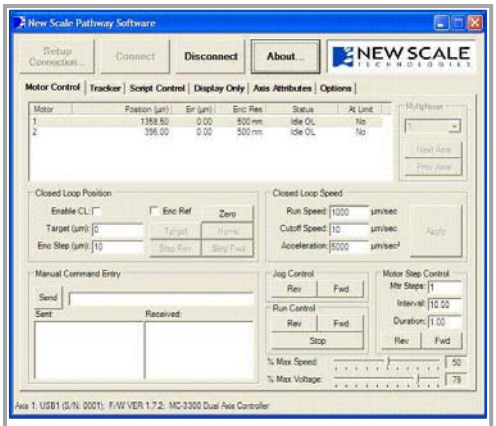


Figure 6: New Scale Pathway software facilitates evaluation of motor performance and definition of system specifications.

This technical bulletin replaces SQL-RV-1p8_Motor_datasheet rev E of 8-23-12