

## M3-RS-U-360

# Rotary Stage Positioning Module

Miniature piezoelectric smart stage with embedded controller

- **Smallest rotary stage:** < 12 mm diameter
- Embedded closed-loop controller
  - *No separate electronics needed*
  - 3.3 VDC input
  - Accepts direct motion commands (I<sup>2</sup>C, SPI, UART or analog servo)
- Continuous 360° rotary motion
- Angular resolution 0.025 deg (440 μrad) closed loop with built-in absolute position sensor
- Angular resolution 0.0057 deg (100 μrad) open loop with external position sensor provided by user
- Holds position with zero power and no jitter
- Millisecond step and settle times

### Smallest size, high resolution

The M3-RS-U-360 Rotary Stage positioning module is a miniature “all-in-one” rotary positioning stage with built-in controller. The precision smart stage *with embedded controller inside* is only 12 mm diameter x 12.5 mm tall. It operates on battery power and is ideal for use in miniature instruments and handheld devices.

The piezoelectric stage provides continuous 360° rotation with absolute position feedback. Patented piezoelectric motors along with position sensors, bearings, drive electronics and embedded firmware are all integrated into this rotary micro stage.

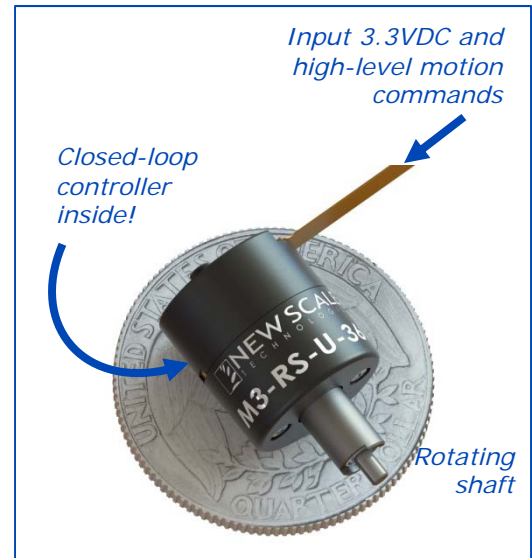
### Embedded controller means tiny size plus fast, easy integration

The embedded controller in the micro stage gives you the smallest system size -- no need for an external controller. It also makes for fast, easy integration into your system.

The smart stage accepts direct input of high-level digital motion commands from your system processor over UART, SPI, I2C or analog servo interface. Developer’s kits include a USB adapter for PC control, and New Scale Pathway™ software.

### Low power for hand-held systems

The M3-RS-U Rotary Stage positioning module needs only 3.3 V DC and uses approximately 500 mW when moving. It can be powered by USB or standard batteries. The integrated piezo motor holds position without using power.



**The M3-RS-U Rotary Stage** positioning module is an ultra-compact positioning stage with embedded closed-loop control. This smart stage accepts direct input of simple motion commands via I<sup>2</sup>C, SPI, UART or analog servo interface.

### APPLICATIONS

Only 12 mm in diameter, this smart stage is ideal for scientific and industrial applications requiring precise rotational positioning in a limited space.

- Point-to-point beam steering (*available with optional mounted mirror – see our developer’s kits*)
- Optical tuning (with gratings or filters)
- Sample alignment



**M3-RS-U Rotary Stage** positioning module with optional mounted mirror (M3-RS-U-Mirror-01-03) for point-to-point beam steering.

## Closed-Loop versus Open-Loop Stepping

An important and standard feature of the M3-RS-U Smart Rotary Stage is the ability to move in using both open-loop and closed-loop commands from the SPI, I2C or UART interface.

### Closed-loop stepping

Closed-loop stepping achieves specific shaft angles in minimum increments equal to the resolution of the embedded absolute position sensor. The desired shaft angle is achieved by:

- (1) Receiving the target command from the host processor
- (2) Reading the current shaft angle from the position sensor
- (3) Calculating and commanding the appropriate drive signal for the piezoelectric motor to achieve the desired angle
- (4) Repeating steps (2) and (3) until the target angle is achieved

Closed-loop stepping provides superior repeatability and accuracy, but requires more time to “step and settle” when compared to open-loop stepping.

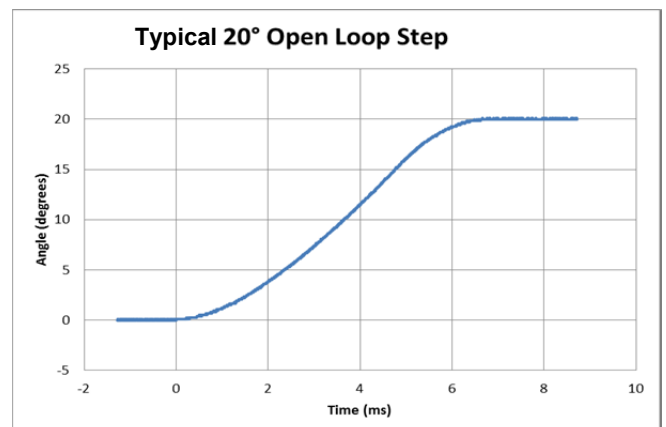
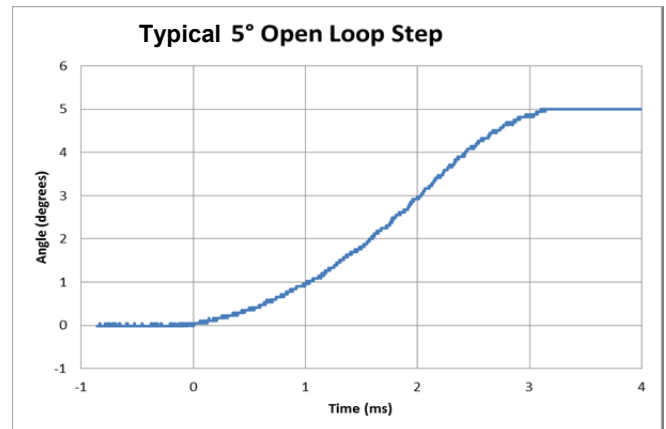
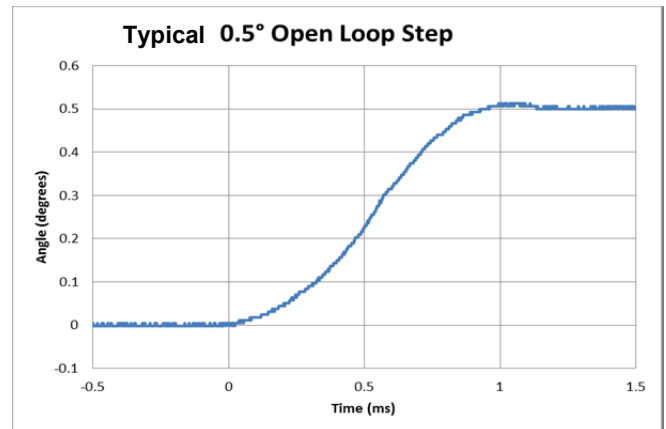
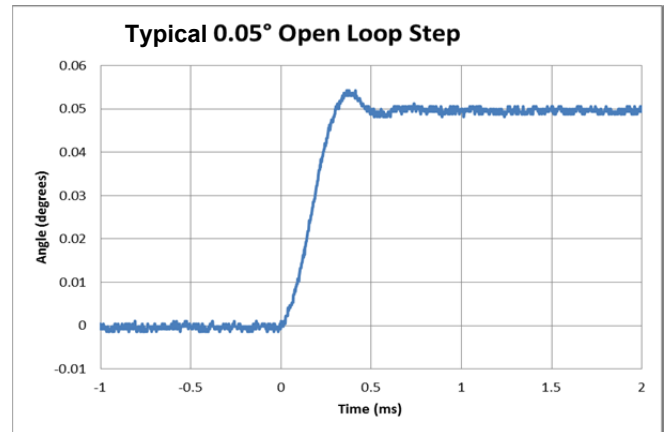
### Open-loop stepping

Open-loop stepping rotates the shaft using only the piezoelectric motor that is commanded to move in “sub-steps.” The magnitude of the sub-steps is smaller than the internal position sensor resolution and allows more precise shaft movement. This is particularly useful in applications that have an external sensor with better resolution than the internal sensor or where very fast “step and settle” performance is required.

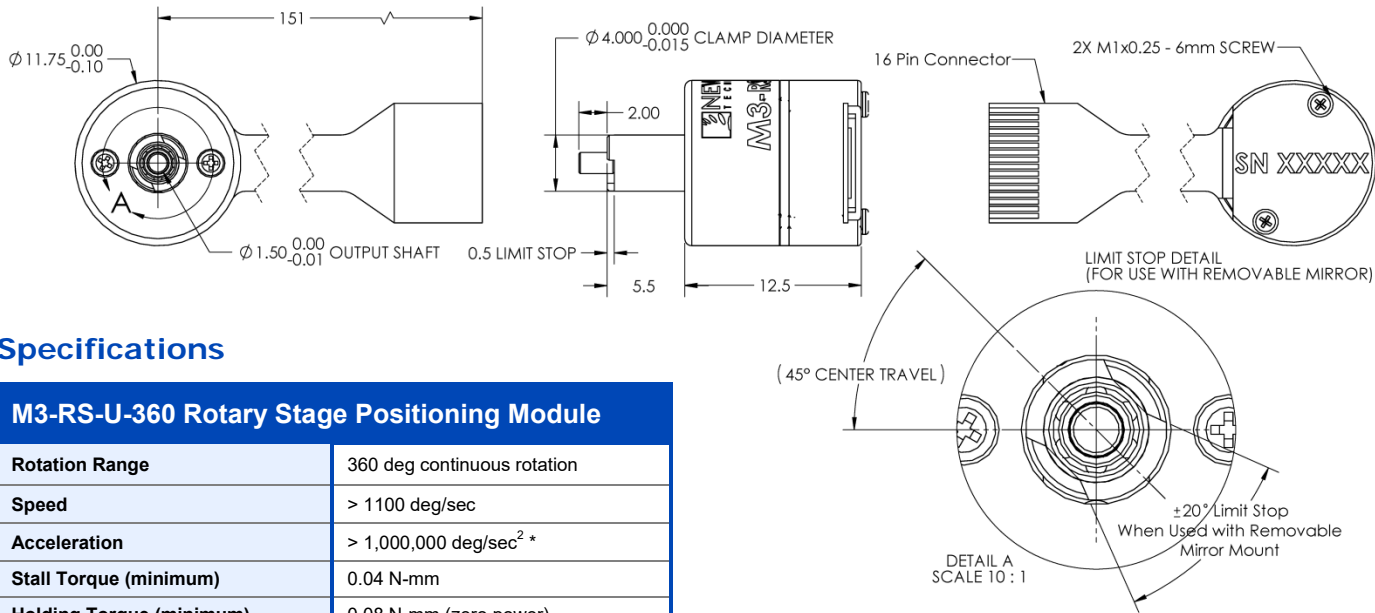
Motor sub-steps are commanded from the host processor by defining the Direction, Velocity, and On-time for the piezoelectric motor. The combination of Velocity and On-time determines the magnitude of each sub-step.

Many factors impact the accuracy of open-loop steps including the external load, direction, absolute angle, and magnitude of the step. Options for improving the precision of open-loop stepping include:

- a. Calibration of motor sub-step size for specific operation conditions using an external sensor and fixed look-up table.
- b. Real-time calibration using the internal closed-loop sensor to measure the average size of multiple motor sub-steps.



**M3-RS-U-360**



**Specifications**

M3-RS-U-360 Rotary Stage Positioning Module	
Rotation Range	360 deg continuous rotation
Speed	> 1100 deg/sec
Acceleration	> 1,000,000 deg/sec <sup>2</sup> *
Stall Torque (minimum)	0.04 N-mm
Holding Torque (minimum)	0.08 N-mm (zero power)
Recommended Maximum Payload mounted to rotating shaft (Payload must be balanced)	
Mass	3 g
Inertia	350 g-mm <sup>2</sup>
CLOSED-LOOP performance (with built-in position sensor)	
Recommended Step Frequency	Up to 100 Hz
Resolution (encoder resolution)	0.025 deg (440 μrad) absolute
Repeatability	+/-0.05 deg (880 μrad)
Accuracy	0.25 deg (4400 μrad)
Maximum Closed-Loop Step & Settle Times (0.96 g-mm <sup>2</sup> inertial load*)	
0.5 deg	9 ms
5 deg	14 ms
20 deg	21 ms
OPEN-LOOP performance (external position sensor provided by user)	
Resolution	< 0.0057 deg (< 100 μrad)
Accuracy	Typically better than 10% of distance travelled after calibration
Maximum Open-Loop Step Times (0.96 g-mm <sup>2</sup> inertial load*)	
0.05 deg	0.50 ms
0.5 deg	1.6 ms
5 deg	6 ms
20 deg	10 ms
Input Voltage	3.3 V DC
Power Consumption (typical)	500 mW active, moving 190 mW active, ready 50 mW standby
Stage Mass	3 g
Operational Lifetime	> 2,000,000 random positions**
Temperature/Relative Humidity	0 to +60 C, non-condensing
Communication Interface	I <sup>2</sup> C, SPI, UART, analog servo <i>Input directly to M3-RS</i>
Controller	Integrated into stage, 64 MIPS <i>NO external controller needed</i>

**Additional information**

Visit the website for CAD files and user manuals:  
<http://www.newscaletech.com/downloads/software-cad-manuals.php> (registration required).

**Ordering information**

Model	Description
<b>M3-RS-U-360</b>	<b>Rotary Stage Positioning Module</b> Piezo smart stage with built-in controller and M3-RS-U-FPC-0-150 flex cable
<b>M3-RS-U-FPC-0-150</b>	<b>Flex cable for M3-RS-U-360</b> Straight, 150 mm length (standard cable, included with the stage)
<b>M3-RS-U-FPC-90-150</b>	<b>Flex cable for M3-RS-U-360</b> 90° angle exit from stage, 150 mm length (optional cable)

**Developer's kits**

Developer's kits are available with a mounted mirror for beam steering applications. See the data sheets for developer's kits model DK-M3-RS-U-1M-20 and DK-M3-RS-U-2M-20-L.

* With inertial load of mounted mirror M3-RS-U-Mirror-01-11	
Internal Stage Inertia	0.39 g-mm <sup>2</sup>
Mirror Clamp	0.44 g-mm <sup>2</sup>
Mirror	0.13 g-mm <sup>2</sup>
Total Inertia	0.96 g-mm <sup>2</sup>

\*\* Significantly longer life may be available depending on the use case. Please consult the factory.