NEW SCALE TECHNOLOGIES
Ingeniously Small Motion Systems

APPLICATION NOTE
Rev. 1 | Feb. 8, 2010

Reference design using SQUIGGLE® micro motors & TRACKER™ position sensors

Tiny optical zoom module for higher-resolution imaging in smaller devices

A reference design for a tiny zoom module demonstrates New Scale's ability to design and produce micro modules that allow OEMs to embed higher-resolution imaging in smaller devices. With integrated SQUIGGLE micro motors and TRACKER position sensors, the module offers 4 mm of travel and 0.5 µm closed-loop position resolution in a thin 6.5 x 13 x 23 mm module (Figure 1).

New Scale works with OEM designers to create custom modules for micro imaging applications including consumer, medical and industrial devices.

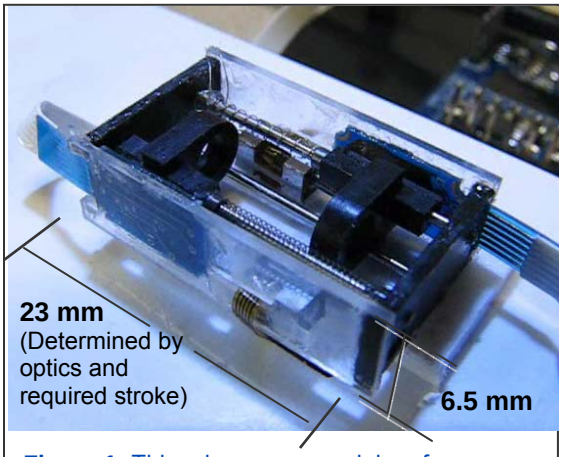


Figure 1: Thin micro zoom module reference design integrates two SQUIGGLE motors, two TRACKER position sensors and two lens assemblies in a 6.5 x 13 x 23 mm package for optical zoom. It features:

- 4 mm stroke (customizable to 30 mm)
- 0.5 µm closed-loop position resolution
- magnetic position sensor - *no light source needed* for the sensor
- absolute position sensing - *no zero reference sensor needed*

Overview

SQUIGGLE micro motors are smaller, more power-efficient and more precise than stepper motors for micro optical systems. Unlike MEMS or voice coil actuators, they also provide long travel for zoom as well as high precision for autofocus. **TRACKER position sensors** are tiny, high-resolution magnetic encoders. Unlike optical encoders, they do not require a light source or external zero reference sensor.

By combining these technologies, New Scale has created designs for uniquely small and precise motion modules. The reference design for an optical zoom module (Figure 2) showcases the components integrated for high-precision lens motion:

- Two SQL-RV SQUIGGLE motors
- Two TRACKER NSE-5310 position sensors
- Two moving lens holders
- Rail assembly with a spring preload, providing zero backlash for precise bi-directional repeatability
- Motor control ASIC (external to the module)

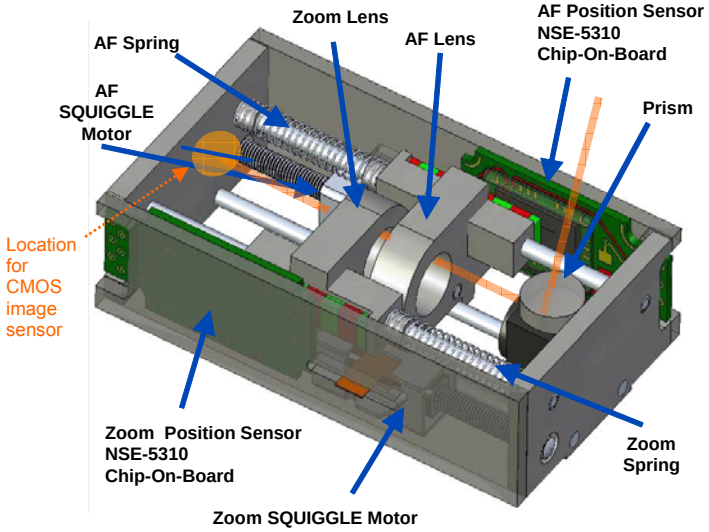


Figure 2: Optical zoom module reference design

▪ 121 Victor Heights Pkwy ▪ Victor, NY 14564
Phone (585) 924-4450 ▪ FAX (585) 924-4468 ▪ www.newscaletech.com

The reference design demonstrates precision optical zoom in the thinnest assembly possible (**6.5 mm height**) with SQUIGGLE motors. The length of the reference design module is 23 mm; actual length would be determined by the OEM's optics design and required stroke. The width of the reference design module is 13 mm; actual width would be determined by the OEM's optics and shutter.

The closed-loop motion module is driven two NSD piezo motor drive ASICs, each in a 1.8 x 1.8 x 0.6 mm BGA package.

Working demonstration modules (without imaging components) based on this reference design are available to qualified OEMs. New Scale works with each OEM to design modules specific to the OEM's needs, and can provide prototype production services and ramp up to large-scale manufacturing.

System description

A zoom camera system block diagram is shown in Figure 3. (The gray-shaded blocks are not included in the reference design module.)

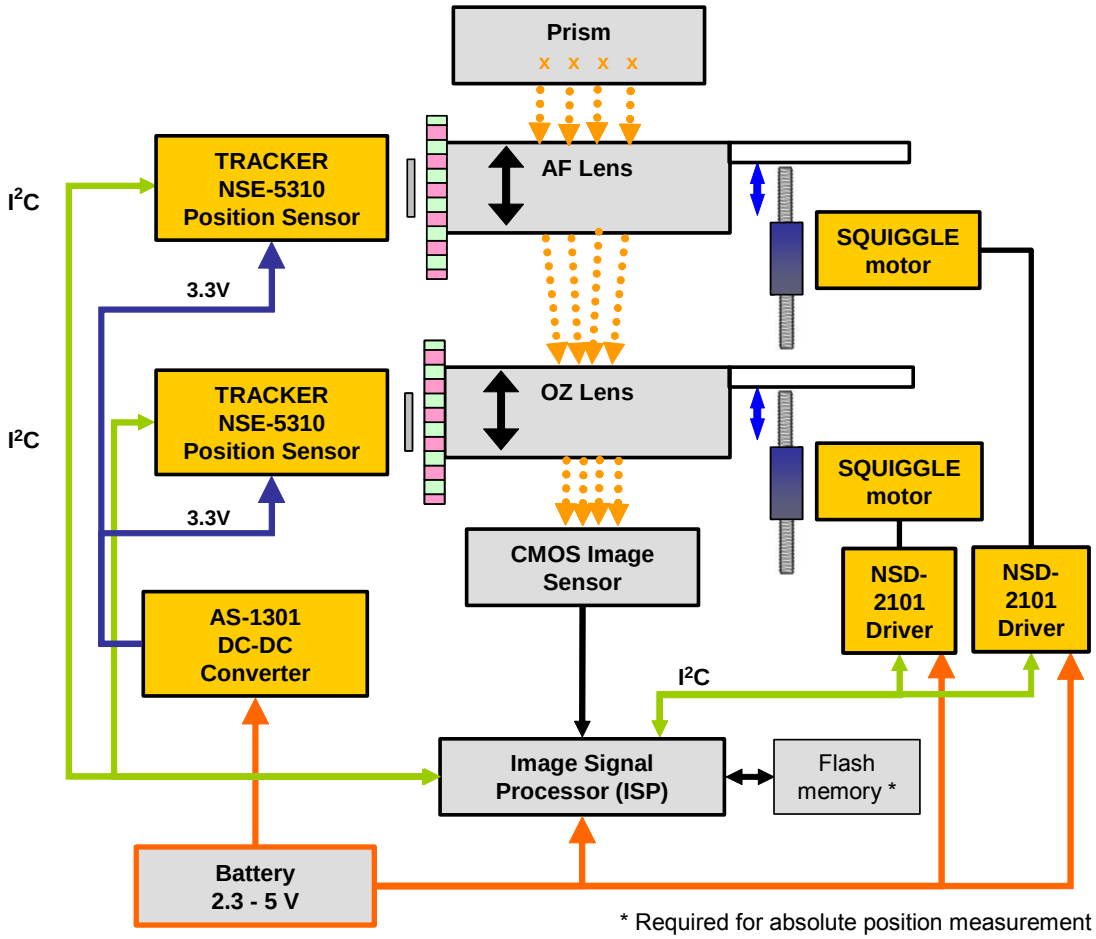


Figure 3: Zoom system block diagram

Imaging components

The reference design assumes that the OEM will select the imaging components: an autofocus (AF) lens, an optical zoom (OZ) lens, a CMOS image sensor and an image signal processor (ISP). A prism can be used to "fold" the light path and enable the thinnest possible assembly, especially for consumer devices.

New Scale provides the motion technology to maximize the performance of high-end imaging components such as larger image sensors (5MP, 8MP and up) and precision lenses. Our precision motion technology ensures that sharp, focused images are projected onto the sensor, while respecting the low power budgets and miniaturization requirements of system designers.

Lens holders and rail system

The lens holders slide along a three-point rail system designed for smooth linear motion.

Micro motors

One SQUIGGLE micro motor is used to move each lens holder along the rails. This robust piezoelectric motor provides high-precision linear motion. In operation, the screw rotates freely against a low-friction surface on the lens holder, held in contact by the spring preload (Figure 4). The screw pushes the load in the "forward" direction against the spring load. In the "reverse" direction, the spring pushes the load as the motor screw retracts and provides precision control of the motion, with zero backlash for the most precise bi-directional repeatability.

The SQUIGGLE motor holds its position without drawing any power. Its high speed enables users to quickly zoom and focus, further reducing power use and providing excellent user experience.

Key features of the SQUIGGLE motor:

- Tiny 2.8 x 2.8 x 6 mm
- Lightweight 0.16 grams
- Fast 7 mm / sec
- Precise 0.5 µm resolution
- Low power use 0 mW to hold position
< 340 mW moving
- Simple & robust no gears or lubrication
- Quiet, ultrasonic operation

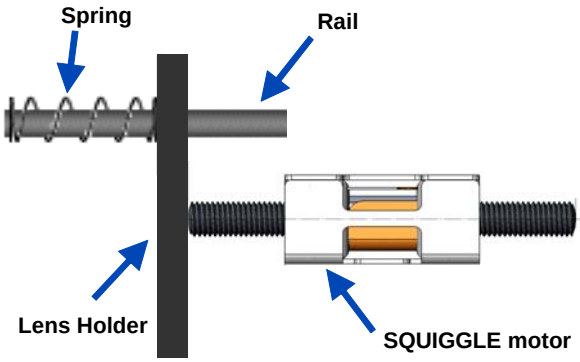


Figure 4: SQUIGGLE motor pushes against the lens holder, with a spring proving the preload for "forward" motion and the push force for "reverse" motion along the rail.

Position sensors

The TRACKER NSE-5310 is a magnetic sensor array with 0.5 µm resolution and integrated on-chip digital encoding. It delivers absolute positioning in a 2 mm range. Unlike optical encoders or stepper motors, it does not require a separate zero-reference sensor.

In the reference design module the sensor is packaged using chip-on-board packaging for the thinnest profile of 0.6 mm. In high volume production quantity, it is available in an even smaller, wafer-level chip-scale packaging as small as 2.5 x 3.9 x 0.6 mm package size. Including the magnet, the sensor can be fit in a space less than 1.5 mm thick.

In the zoom module reference design, a magnetic strip with alternate north-south poles is mounted on the lens holder and positioned above the sensor (Figure 5). A Hall sensor array on the TRACKER NSE-5310 chip measures the spatially-varying magnetic field produced by the moving magnetic strip. An integrated digital encoder on the chip provides direct digital output of the absolute linear position within a 2 mm pole pair on the magnet.

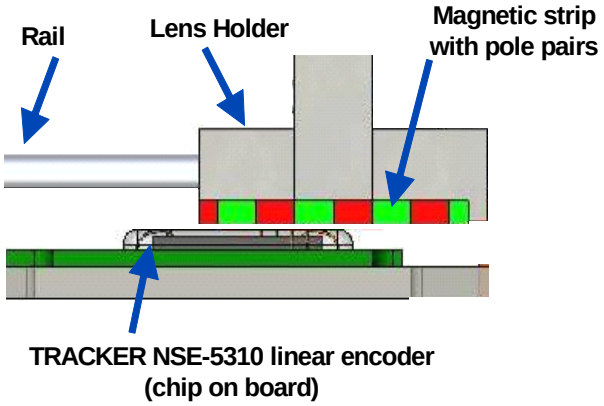


Figure 5: TRACKER NSE-5310 position senor provides closed-loop feedback of lens holder position with 0.5 µm resolution. A magnetic encoder is smaller than optical encoders and needs no light source.

By counting pole pair crossings and storing this information in flash memory, a system processor can determine absolute position along the length of the magnet.

The absolute magnitude of the magnetic field intensity is used to detect the end of the magnetic strip and serves as a built-in zero reference. Standard I^2C protocol enables simple integration into the system processor.

Key features of the TRACKER NSE-5310 position sensor:

- Tiny: at 2.5 x 3.9 x 0.6 mm, it is less than half the size of optical encoders
- Precise: 0.5 µm resolution
- NO light source: eliminates potential source of image degradation
- NO external zero reference sensor
- Absolute encoder (with flash memory) – no need to hunt for zero position on power-up, meaning lower power use and less wait time for users to capture images

NSD-2101 motor driver

Two NSD-2101 piezo motor driver ASICs are powered by a single 3 V battery. Like the TRACKER, the NSD-2101 uses a standard I^2C interface for integration with the system processor.

The NSD-2101 uses patented full-bridge switching technology to create the ultrasonic motor drive frequency. The IC also has patent-pending smart drive features built in that optimize motor performance while minimizing power consumption over a broad range of operating and environmental conditions. A power-down mode provides for minimal power consumption in stand-by.

For the demonstration module, the NSD-2101 ICs are integrated into New Scale's MC-3300-RV motor controller (Figure 6). This control board has convenient connectors for the SQUIGGLE motors and TRACKER position sensors. It connects to a PC via USB connector.

New Scale Pathway™ Software provides an easy to use, "point and click" user interface for easy evaluation of the demonstration module. Scripts for focus and zoom demonstration are included. A powerful script generator allows users to create and run their own scripts to evaluate module performance and for embedded system development.

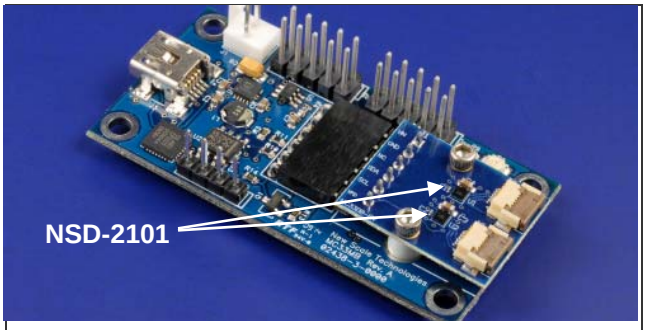
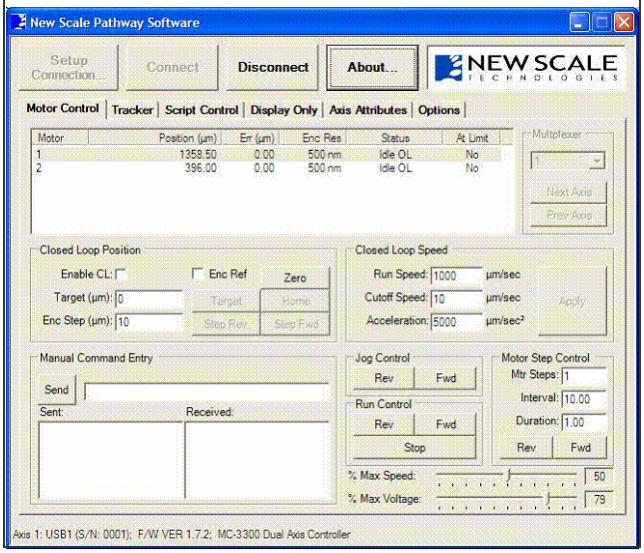


Figure 6: Above: Two NSD-2101 motor drive ASICs in the MC-3300-RV development platform. Below: New Scale Pathway software for motor and sensor evaluation and system development.



Advantages over other zoom modules

The zoom system using SQUIGGLE motors and TRACKER position sensors offers the distinct advantages of smaller size, higher precision and lower power use compared to zoom systems that employ stepper motors.

The very low height profile (6.5 mm) is of particular benefit in many micro camera applications. Length and width are also very small and will be determined by the OEM's optical design parameters.

The combination of SQUGGLE motor with the spring preload creates precision motion with zero backlash.

With a stepper motor, error can accumulate through the motor, lead screw and coupling to lens holder. With the TRACKER, the lens is directly measured by the encoder for greater precision.

Typical performance

Table 1 shows the performance of New Scale's demonstration modules based on the optical zoom reference design. Please refer to our product data sheets for additional specifications on SQUIGGLE motors and TRACKER position sensors.

Table 1: Optical zoom module reference design performance

Size	6.5 X 13 X 23 mm
Auto Focus Stroke	4 mm (customizable up to 30 mm)
Optical Zoom Stroke	4 mm (customizable up to 30 mm)
Position Resolution	0.5 µm
SQUIGGLE Motors	Two SQL-RV-1.8-6
TRACKER Position Sensors	Two NSE-5310 in chip-on-board packaging
Driver IC	Two NSD-2101 in 1.8 x 1.8 x 0.6 mm BGA package
Zero Reference Sensors	None Required
Audible Noise	< 35 dB (in housing)
Operating Temperature	-30°C to +70°C
Storage Temperature	-40°C to +80°C
Lifetime	>300,000 cycles

Learn more

This design demonstrates a customizable platform to meet unique OEM optical and system needs. Our custom engineering group works with OEM designers to create focus and zoom modules to suit your application. Contact New Scale today at +1 585 924-4450, email sales@newscaletech.com.

 ▪ 121 Victor Heights Pkwy ▪ Victor, NY 14564
Phone (585) 924-4450 ▪ FAX (585) 924-4468 ▪ www.newscaletech.com