PIEZO
MOTOR COMPANY

INSTRUCTION MANUAL

ROMO Series Rotary Piezoelectric Actuator Evaluation Kit with and Without Factory-Installed Encoder

Rev. 05202025

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OEM Evaluation Kit Instruction Manual

1. Introduction

Welcome to the realm of precision motion with the ROMO Series rotary piezo actuator, crafted for unparalleled accuracy and efficiency. This manual will guide you through the operation and features of our innovative rotary piezo actuator. The included evaluation kit provides all the essential components needed to fully explore the actuator's capabilities.

The ROMO Series sets new benchmarks for compact, high-performance rotary piezoelectric actuators by merging a lightweight design with superior precision and functionality. These actuators are exceptionally energy-efficient, requiring no power in the hold position while still maintaining full torque. This efficiency makes them ideal for demanding OEM applications where performance and cost-effectiveness are crucial.

Each evaluation kit comes complete with an electronic driver PCB specifically designed for the ROMO piezo actuator, all necessary cables, and a dual-voltage 120/220 VAC to 7.5 VDC universal power supply.

The ROMO Series rotary motors are offered with optional factory-installed encoders and are available with a standard hollow shaft. We also provide customized versions of the ROMO, including options with a lead-screw type metal shaft.

2. Properties

The ROMO Series actuators boast several distinctive features:

- Construction from modern, reinforced engineered thermoplastics for reliability and affordability.
- Unmatched precision and resolution.
- Ultra-fast response times and exceptional start-stop capabilities.
- High torque relative to size, optimized for direct-drive applications.
- Support for stepping and continuous modes of operation.
- A speed dynamic range spanning six orders of magnitude.
- Silent operation in continuous mode and low voltage design to minimize electrical arcing.

3. Unpacking and Preparation

After unpacking the ROMO series actuator evaluation kit, check the contents against the items listed in the table below. If any items are missing contact your supplier/distributor immediately for replacement parts.

DESCRIPTION
• ROMO series rotary piezo actuator (w/ or w/o encoder)
• Electronic Driver PCB - red
• Power Supply 120/220VAC to 7.5V DC

Table 1 – Description

Figure 1. ROMO rotary actuator (version without encoder).

Figure 2. ROMO-E rotary actuator (with installed encoder).

4. Technical Specifications of ROMO Series Rotary Piezo actuator

Specification	Model
Power Supply Voltage	5.0 to 7.5 V DC
Stall Torque	≥ 4 mNm
Self-Braking Torque	≥ 5 mNm
Actuator Response Time	≈30 µs
Max Speed	> 600 rpm
Minimum Angular Step	≈30 µrad = 200,000 steps per full rotation
Encoder Resolution (after quadrature) *	1,024 ppr
Minimum Controlled Angular Step*	6.1 mrad
Uni-directional Repeatability	6.1 mrad
Angular Backlash	30 µrad
Angular Hysteresis	30 µrad
Frequency Response	4 kHz
Operating Temperature	-20 °C to 80 °C
Maximum Axial Load	200 g
Maximum Radial Load	200 g
Moment of Inertia	29.2 g·mm²
Max Current over velocity range	300 mA
Rotor Runout	≤50 µm
Actuator Weight	6.3 g
Actuator Dimensions (no shaft)	13 x 19 x 9.1 mm
Driver PCB Dimensions	28 X 31 X 9.6 mm
Driver PCB Weight	6.8 g

*Model with factory installed encoder

Table 2 – ROMO Series Rotary Piezo Actuator

5. Mechanical Drawings of ROMO Series Rotary Piezo actuator

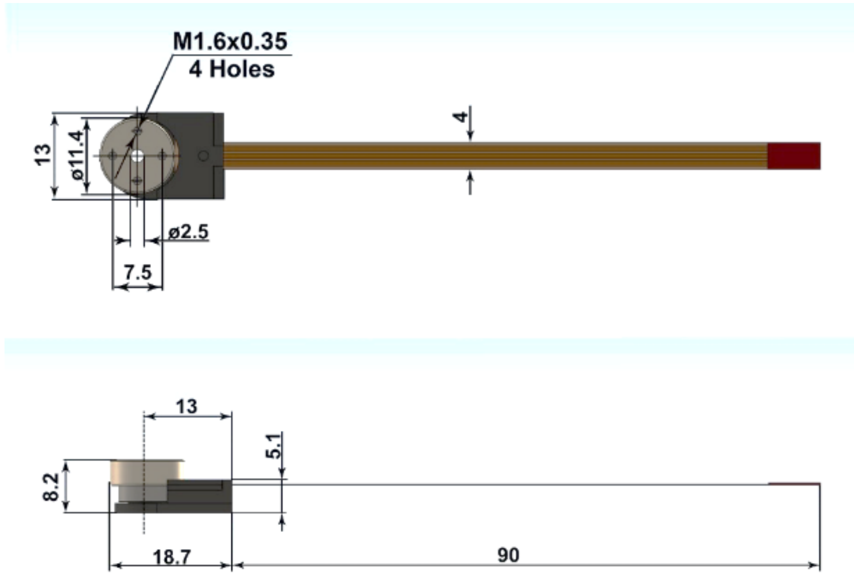


Figure 3. ROMO Rotary Piezo actuator without factory-fitted encoder. Dimensions (mm)

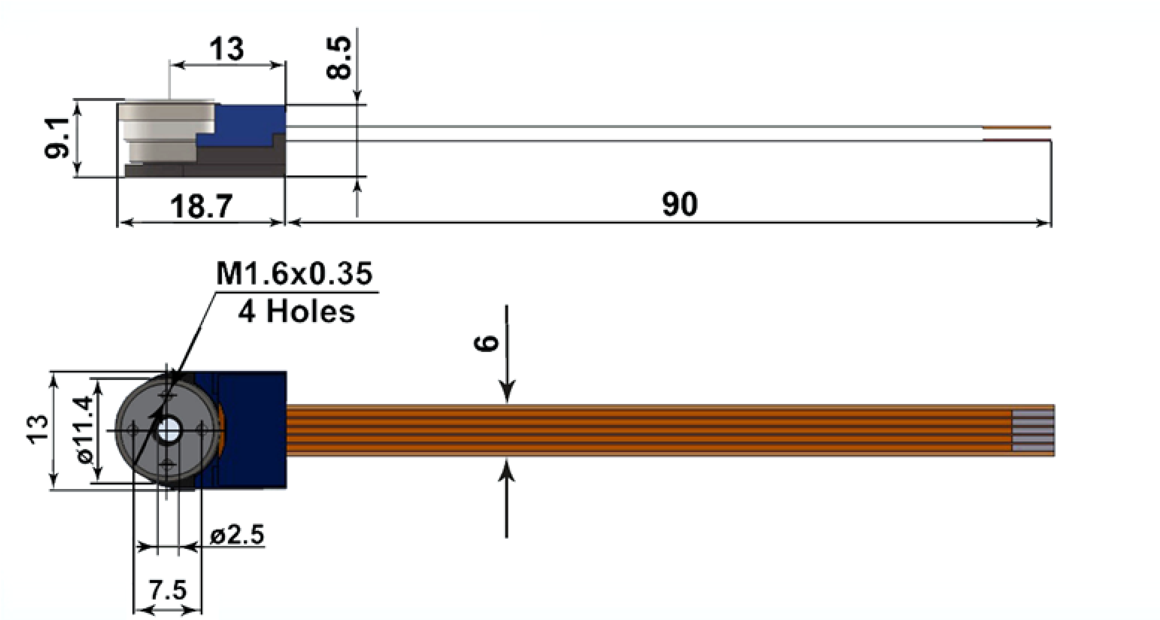


Figure 4. ROMO piezo actuator with factory-fitted encoder. Dimensions (mm)

6. Operation and Control of ROMO Series Rotary Piezo Actuator

6.1 Connecting the Power Supply

Connect the 110/220 VAC to 7.5 VDC Power Supply to the Micro USB connector located on the electronic driver PCB, Figure 4, and connect the opposite end of the Power Supply into a suitable AC power outlet (110/220 VAC). If you wish to power the unit from your own system instead of through the Micro USB connector, you can use the J1 connector, Figure 5. Apply +7.5V (Vdd) to pin 1 or 2, with pin 3 serving as the ground (GND).

NOTE: The ROMO motor can be powered by an USB output from a PC (5V) however the specifications for torque and rotational speed will be 20-30% lower.

6.2 Mounting and Connecting the Driver Board

Connect the piezo actuator to the driver board using the flexible PCB cable, as illustrated in Figure 1. This cable fits into the actuator connector on the board according to Figure 1. To connect the cable, lift the 'locking clip' (motor connector on Figure 6), insert the cable and then lower the 'locking clip' to lock the cable in place. To remove the cable, lift the 'locking clip' and remove the cable.

6.3 Driver Board Operation

The electronic driver PCB is responsible for generating the signals needed to drive the piezo actuator, resulting in rotor rotation, Figure 4. S1 and S2 buttons are used for manual motor control; S1 causes counter-clockwise (Left) rotation, and S2 enables clockwise (Right) rotation.

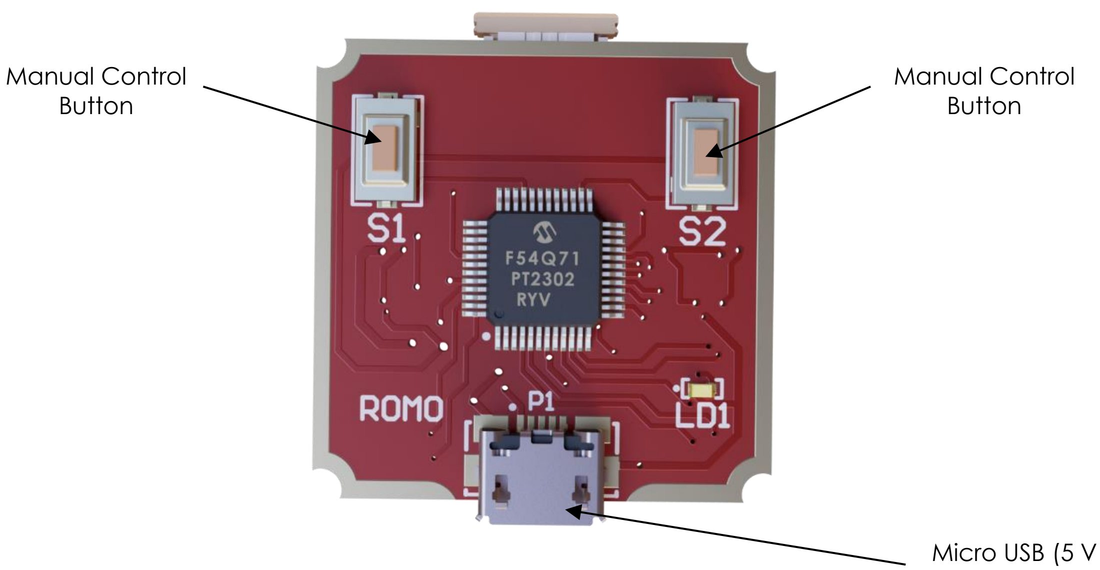


Figure 5. Driver board top view

6.4 Open loop mode control

Control of the ROMO Series motor is achieved by sending PWM (Pulse Width Modulation) control signals to the direction-specific wires on the driver board's "J1" connector, Figure 5, specifically to the "CCW/Left" (J1, pin 6) and "CW/Right" (J1, pin 5), as shown in Table 2. This is based on the required direction of movement. The common ground is provided by J1 GND (pins 3 and 4). To initiate movement, a TTL "high" level voltage (ranging from 2.0 to 5 Volts relative to GND) is applied, whereas a TTL "low" level voltage (0 to 0.8 Volts relative to GND) will halt movement. The wire not in use should either be maintained at a TTL "low" level or left unconnected.

The driver PCB has the ability to support the following interfaces:

- **UART interface** - The motor can be controlled by using UART commands through the pins 1,2,6 (TX,RX,GND) of J2 connector.

- **I2C interface** - The motor can be controlled using I2C interface through the pins 1,2,6 (SDA, SCL, GND) of J2 connector.

Note: Manufacturer programs the driver PCB for the specific interface required and provides Instructions with a list of commands DIRECTION, START, STOP, OPERATING MODE (PWM, Continuous), PWM (setting).

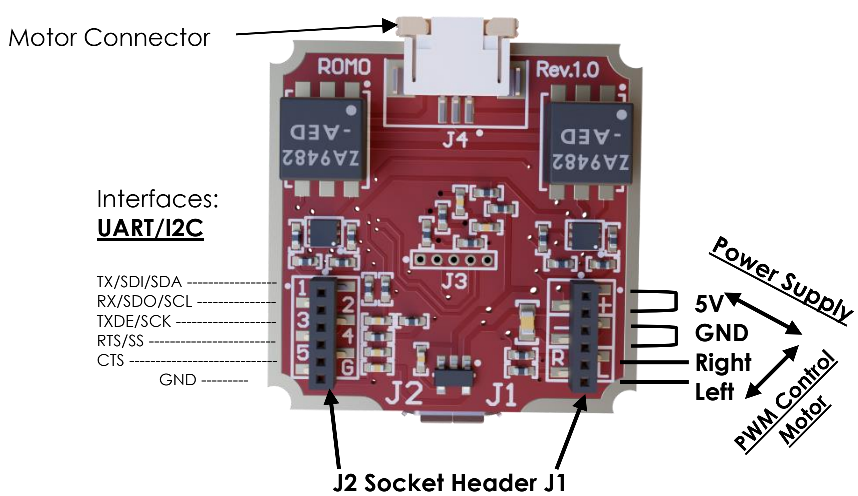


Figure 6. Driver board bottom view

Pin No.	J1	J2
1	5-7.5V	TX/SDI
2	5-7.5V	RX/SDO/SCL
3	GND	TXDE/SCK/SDA
4	GND	RTS/SS
5	Right	CTS
6	Left	GND

Table 3. Driver board Pinouts

6.5 I2C Configuration

- **Address of Board** - 0x40
- **Byte order** - *Little Endian.*

6.6 I2C Instruction Set

The following commands are supported:

Move(mode)

- Command code:1

Size: 1byte.

- Parameter *mode* sets the mode and direction of movement.

Size:1byte.

Valid values for the *mode* parameter:

- 0 – Stop;
- 1 – Move to the Left in Continuous mode;
- 2 – Move to the Right in Continuous mode;
- 3 - Move to the Left in PWM mode (setting up this PWM mode is done using the *PWMTimeSettings* command, the parameters of which operate with the run time and Period);
- 4 – Move to the Right in PWM mode (similar to the previous code, only move to the Right);
- 5 – Move to the Left in PWM mode (setting up this PWM mode is done using the *PWMGeneratorSettings* command, the unit of measurement of the PWM parameters for setting the run time and period is the excitation periods of the motor resonator, not Hz);
- 6 – Move to the Right in PWM mode (similar to the previous code, only move to the Right).

MotorType(motorType)

- Command code:2

Size: 1byte.

- Parameter *motorType* sets the motor type. Using this command allows to ensure the correct direction of motor movement, when selecting the arguments of the movement commands (Left, Right) and pressing the S1 and S2 buttons.

Size:1byte.

Valid values for the *mode* parameter:

- 1 – Linear motor;
- 2 – Rotary motor.

PWMTimeSettings(direction, run_time, period, prescaler)

This command allows the user to configure the motor movement parameters for each direction separately in PWM mode, when the motor is operating in mode equal 3 or 4 (command *Move(mode)*).

- Command code:3

Size: 1byte.

- Parameter *direction* sets the direction of movement, that will be adjusted.

Size:1byte.

Valid values for the *direction* parameter:

- 1 – Left;
- 2 – Right.

- Parameter *run_time* sets the time within the PWM period that the motor will run.

Size:2byte.

Valid values: from 0 to 2^{16}-1 (0 to 65535).

To calculate the *run_time* value use the equation:

$$run\_time = \frac{X}{2us \cdot (prescaler + 1)}$$

where *X* - desired motor running time in microseconds.

- Parameter *period* sets the period of PWM.

Size:2byte.

To calculate the *period* value use the equation:

$$period = \frac{X}{2us \cdot \ (prescaler + 1)}$$

where *X* - desired period of PWM in microseconds.

- Parameter *prescaler* sets divider, that allows to expand the PWM frequency range.

Size:1byte.

Valid values: from 0 to 255.

PWMGeneratorSettings(direction,run_gen_periods,gen_periods_in_PWM_period, prescaler)

This command allows to configure the motor movement parameters for each direction separately in PWM mode, when the motor is operating in mode equal 5 or 6 (command "Move(mode)").

- Command code:4

Size: 1byte.

- Parameter *direction* sets the direction of movement, that will be adjusted.

Size:1byte.

Valid values for the *direction* parameter:

- 1 – Left;
- 2 – Right.

- Parameter *run_gen_periods* sets the number of periods of excitation of the motor resonator within the PWM period that the motor will run.

Size:2byte.

Valid values: from 0 to 2^{16}-1 (0 to 65535).

To estimate the motor run time (in seconds) that corresponds to the specified number of periods of motor excitation, use the equation:

$$Run\ Time = \frac{run\_gen\_periods\ \ \cdot (prescaler + 1)}{Fgen}$$

where *Fgen* - motor resonator excitation frequency (in Hz), changes during motor operation, the average value is approximately equal 338kHz.

- Parameter *gen_periods_in_PWM_period* sets the number of periods of excitation of the motor resonator within the PWM period.

Size:2byte.

Valid values: from 0 to 2^{16}-1 (0 to 65535).

To estimate the time (in seconds) that corresponds to the specified number of periods of motor excitation use the equation:

$$Period\ Time = \frac{gen\_periods\_in\_PWM\_period \cdot (prescaler + 1)}{Fgen}$$

where *Fgen* - motor resonator excitation frequency (in Hz), changes during motor operation, the average value is approximately equal 338kHz.

- Parameter *prescaler* sets divider, that allows to expand the PWM frequency range.

Size:1byte.

Valid values: from 0 to 255.

In the steady-state motion of the motor—after the initial transient response—each excitation period of the generator corresponds to one discrete step of the motor. Therefore, when operating in PWM mode, instead of defining motor operation time in the conventional sense, you can control motion by specifying the number of excitation periods. This approach allows you to command the motor to perform a specific number of steps rather than run for a set duration.

The actual size of each step depends on the load applied to the motor. However, the average step size can be estimated and used in calculations. Alternatively, you can specify a small number of excitation periods (e.g., several dozen) to produce fine incremental movement.

The average motor step size during continuous operation can be estimated using the following equation:

$$step\ size = \frac{motor\_speed}{Fgen}$$

where $Fgen$ motor resonator excitation frequency (in Hz), changes during motor operation, the average value is approximately equal 338kHz.

motor_speed **-** measured motor speed by improvised means or using the *Move* command (in distance per second).

For example, if for linear motor *motor_speed=50mm/s,*

then

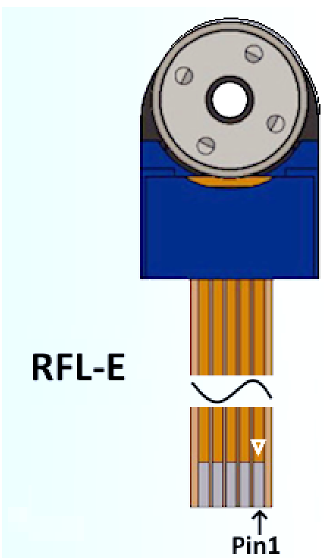
$$step\ size = \frac{50}{338000} \approx 150nm$$

6.7 Demonstration program

Simultaneous pressing of the two Manual Control Buttons on the driver for 3-5 seconds activates a factory installed demonstration program, which illustrates the actuator operation in various modes (Continuous and PWM).

6.8 Closing the loop with factory-installed encoder

The rotary piezo actuator with installed magnetic encoder (Model ref. MagAlpha MA702) has a resolution, after quadrature, of 1,024 ppr. If the user wants to monitor the actuator movement or close the loop, the signals from the actuator encoder can be read from the flat cable as shown in Figure 6 (i.e. Channel A – pin 5; Channel B – pin 3; Z (Zero) channel – pin 4).



Encoder: MagAlpha MA702
Resolution: 0.3516 deg (quadrature) - 1024 edges per turn

Pin No.	Name	Description
1	VDD	Supply 3.0-3.6V
2	GND	Supply ground
3	B	Sin
4	Z	Zero angle position
5	A	Cos

Figure 6 – MagAlpha MA702 Encoder Pinouts

NOTE: The user can close the loop by using PWM, UART or I2C control (see description in the Open Loop Control section).

7. Example Modes of Operation

7.1 Stepping and Continuous Modes

The ROMO Series can be operated in stepping or continuous mode, depending on the type of signal applied to the PCB Pins of J1 connector Figure 5. A constant "high" level (TTL) signal will result in continuous motion at maximum speed. A pulse or pulse train will result in stepping operation.

In the stepping mode (PWM mode), the size of each step is determined by the pulse duration, and the speed of travel is determined by the pulse repetition rate. The minimum pulse duration is around 30-40 µs. The maximum repetition rate F, measured in Hertz, is determined by the Dynamic range of the piezo actuator.

Example PWM Control Setting for Minimum Step (approx. 0.04 µm)

- Set Pulse Duration to between 30 µs - 40 µs
- Set Frequency to between 10 Hz - 150 Hz

Example setting for stepping (PWM) mode operation with 50% duty cycle

- Set repetition rate/frequency = 100 Hz (period of 10 ms)
- Set pulse duration = 5 ms.
- Duty cycle = 50%.

The maximum recommended repetition rate for PWM control of the actuator is 4 kHz using the driver PCB supplied with your actuator.

8. Recommended settings to avoid overheating.

ROMO Series piezo actuators are designed for precise control applications using a duty cycle. They are not designed for prolonged operation in Continuous (non-stepping) Mode, which can lead to overheating of the actuator and possible internal damage not protected under warranty.

To avoid overheating of the actuator please follow the guidelines in the table below and ensure that motion control settings for Continuous Mode and/or Stepping (PWM) Mode are within the limits specified in the table below.

For applications requirements exceeding the recommended guideline, please contact our Technical Support.

Model #	Max. Operating Power Continuous Mode (W)	Max. Operating Power PWM Mode (W)	Recommended PWM Duty Cycle	Maximum Duration in Continuous Mode
ROMO Series (300 mA)	2.25 W	0.5 W	<20%	10 s

Table 4 – Recommended settings to avoid overheating.

9. Technical Support

For technical support please contact: info@piezomotors.com

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