U-Series Specification

Important Information When Using Our Products

Please note that Ultra Motion's commercial off-the-shelf (COTS) products are not intended for use in critical applications where failure of the product may cause bodily harm or death. Please consider the following information when designing our products into your system.

Performance

All commercial off-the-shelf products manufactured by Ultra Motion are designed to meet the performance specifications we publish in the product's manual. All life related data is provided as reference only and does not take into account application specific factors that can have significant impacts to the overall life of the product. Application specific factors can include: design loads, transient loads (shock, vibration, inertia), speed, environmental stresses (temperature, contamination), etc. Due to the fact that application specific factors can greatly affect the product's life, it is not possible to provide a generalized Mean Time Before Failure (MTBF). It is the customer's responsibility to determine the suitability of the product for their particular application.

Software

U-Series products are assembled without integrated or internal control electronics. Ultra Motion can quote or recommend compatible external drives or programmable controllers if necessary.

Change Control

Commercial off the shelf products are subject to changes that do not affect form, fit, or function. These changes can include the use of different internal part revisions, suppliers, coloration, etc. Ultra Motion has the ability to track and manufacture version locked designs if your project has specific change control requirements. In a version locked design, the customer will be notified before any changes are made to their product.

Quality Control

Ultra Motion actuators are manufactured under our internal quality management system. 100% of the product we manufacture goes through a complete performance QC inspection before leaving our facility. Documented results of QC records are available to all customers.

Safety Information

IMPORTANT: Read this manual before installing and operating Ultra Motion U-Series actuators. Failure to read this section can result in personal harm or damage to the product.

Safety Disclaimer

The U-Series is intended to be a subcomponent of a larger piece of machinery or automated system. This section is not intended to provide the safety guidelines for the entire machine or system that the actuator is installed into. It is the responsibility of the purchaser or system designer to assess the risks and safety requirements of the end application they are designing.

Safety Warnings

- Once powered, the actuator is capable of rapid motion and can produce large amounts of force. Always ensure that safe clearances from people and equipment are maintained before applying power.
- While the U-Series operates on low voltage (24 to 48 VDC typical), you must still use caution when handling and working around the actuator to avoid electrical shock.
- The motor of the actuator can become very hot, especially at high current draws. Take adequate time to cool before handling, and provide adequate ventilation for cooling of this device.

Safety Notifications

As you read through the manual, you will notice certain safety notifications that indicate other important safety related information.

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Revision History

Revision	Date	Details
A.01	3/21/2024	Initial Release
A.02	4/3/2024	Modified configuration style
A.03	5/19/2025	Minor corrections throughout

U-Series Overview

For 30 years Ultra Motion has been a leading supplier of pressure-compensated oil-filled linear actuators for the most critical subsea applications. Our unique design allows for reliable actuation to depths greater than 6,000 meters below sea with self-compensation and an extremely small footprint. We offer the most cost effective PBOF solutions in the industry where power density, size, and reliability are critical.

The U-Series is an internally pressure-compensated oil-filled electromechanical actuator rated for operation to depths of 20,000 feet (6,000 meters). The U-Series has a variety of options including Nema 17 (U1) and Nema 23 (U2) stepper motors or brushless DC motors, self-locking Acme leadscrews or high efficiency ballscrews, in-line planetary gearheads, and strokes ranging from 1" to 16". All U-series actuators come with an internal linear potentiometer for absolute position feedback, and will require external motor control electronics to operate. Please look into our AU Servo Cylinder product line if built-in control electronics are of interest.

Typical applications

Our submersible products are commonly used to operate hydroplanes on subsea vehicles, deploy instruments/accessories like float releases or sensors, raise masts/antennas on USVs, control hydrofoils or rudders on USVs, actuate subsea valves, and more.

Features

- Pressure compensated oil-filled assembly with built-in compensator
- 6000+ meter operating depth (10,000 psi)
- Built-in linear potentiometer for absolute position feedback
- Stepper motor and brushless DC motor options
- In-line planetary gearhead options
- High efficiency ballscrew or self-locking Acme leadscrew options
- Peak forces up to 500 lbf
- Peak speeds up to 5 in/s
- 2", 4", 6", and 8" strokes standard
- 1" to 16" strokes are available
- 0.005" nominal axial backlash
- -40°C to +60°C operating temperature range in air
- SubConn Wet-Mate connectors standard, custom cable lengths and outputs available.

Motor Heating

The main driver of an electric motor's continuous and peak loading capability is the heat generated in the motor phases due to I^2R losses. Since all Ultra Motion submersible linear actuators are oil-filled, the motor windings are in a greatly increased convective heat transfer environment compared to the air/natural-convection environment used when rating the motors. For this reason, it is possible to overdrive the U-Series and AU-Series actuators to a higher continuous force for long durations. This increased capability also applies to PV-limits of the self-locking Acme nuts. Ultra Motion provides performance information for the actuators operating in a non-oil-filled environment to ensure reliable and conservative operation. Overdriving into a hardstop of against loads greater than the continuous capability can lead to a failure of the motor windings. Contact Ultra Motion engineering for more information for your particular application.

Lubrication

The U-Series actuators are oil-filled which creates an ideal lubrication environment for the mechanical components. These actuators will be lubricated for the life of the application.

Self-Locking Acme Leadscrews

U-Series actuators equipped with Acme 0.0625 inch/rev self-locking leadscrews will hold position against a load with no power to the motor. This is useful for applications that require occasional positioning like sensor deployment or trim tabs, and crucial for low duty cycle applications operating on batteries.

Care must be taken to avoid striking the internal mechanical end stops when using a self-locking leadscrew. Impacting the end-stop with an Acme self-locking screw can lead to a jam of the actuator due to the inertial load generating a static friction between the nut and leadscrew that the motor cannot overcome. Current limits and operating speeds should be set low while becoming familiar with the actuator.

The self-locking Acme leadscrews can produce high frequency noise when operating in certain situations due to a mechanical resonance in the sliding motion of the nut/leadscrew. Ultra Motion screens leadscrews for this phenomenon, but cannot guarantee some high frequency noise won't be produced in certain loading situations.

The maximum static load rating of the U-Series is 500 lbf.

High Efficiency Ballscrews

Applications requiring the best efficiency and highest dynamic performance should use ballscrews. The force required to backdrive an unpowered U-Series will vary with motor type and planetary gearhead ratio. Approximately 5 to 10 lbf will be required for a U1 with BLDC motor, and 30 lbf for a U2 with a stepper motor. Ballscrews offer improved control when small position movements are needed, less than 0.005".

Stroke Length

Ultra Motion recommends keeping the usable stroke length of the actuator ~0.0625" or more in-bounds of the mechanical extend/retract limits. This headroom allows for some control system overshoot without risk of contacting the internal mechanical hardstops. If stroke length and space constraints are concerns, then this headroom can be reduced with caution.

U-Series Cable Mating

The U-Series SubConn connectors must be lubricated with Molykote 44 Medium on every installation. A layer of grease corresponding to a minimum of 1/10 socket depth should be applied to the female connector in dry-mate conditions. A layer of grease corresponding to 1/3 socket depth should be applied to the female connector in wet-mate situations. Angular loads on the cable and mated cable assembly must be minimized. Debris on the male connectors and within the female connector sockets must be cleaned thoroughly before mating with liquid soap, hot water, and isopropyl alcohol.

The U-Series is terminated with a 2-foot whip with SubConn MCIL series connector and DLSA-F locking sleeves.

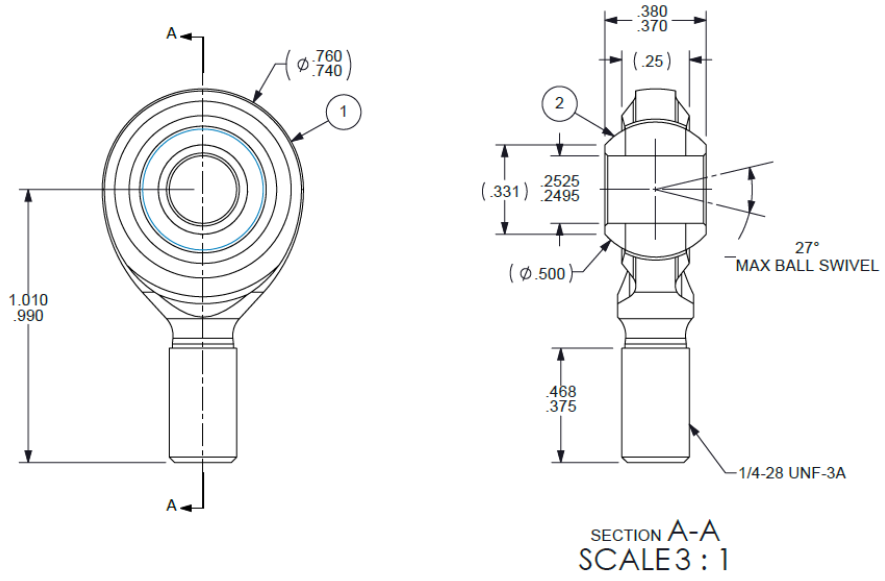
Alternative cable lengths, locking sleeves, cable output orientations, and connector types are possible as custom options.

Radial Loads

All U-Series actuators are designed for axial loading only, radial loads must be minimized/eliminated. Adequate degrees of freedom must be designed into the mounting arrangement to ensure system tolerances do not lead to moment/radial/torque loads on the actuator shaft.

Mounting

The standard U-Series mounting option is ¼-28 threaded holes on either end of the actuator. The body of the U-Series must not be clamped or used for mounting. The pressure-compensation bladder must be able to expand/contract as the actuator retracts/extends in order to ensure proper operation at depth. Ultra Motion offers a range of mounting options including an all 316 stainless steel spherical mount. Contact Ultra Motion engineering for options and details.

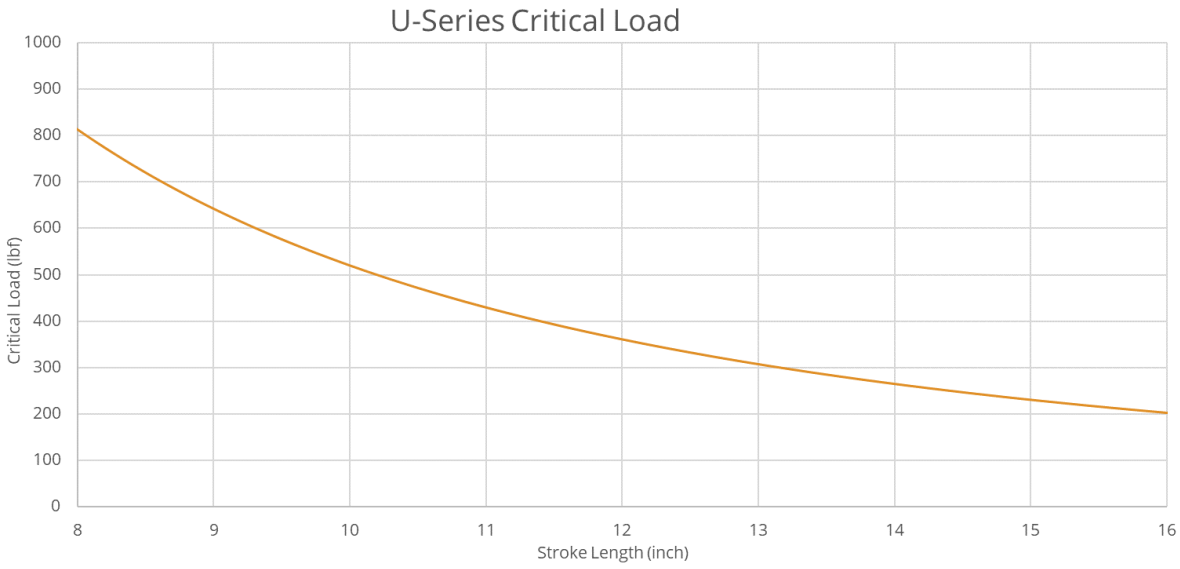


MATERIAL NOTES:
1. BODY - 316 STAINLESS STEEL - PTFE LINED
2. BALL - 316 STAINLESS STEEL

GENERAL NOTES:
1. ULTIMATE RADIAL STATIC LOAD CAPACITY - 897 LBF
2. MISALIGNMENT ANGLE - 27° CLEVIS MOUNTED

Critical Loads

For stroke lengths greater than 10 inches, column loading of the screw will begin to limit the **compressive** force capability of the actuator. The below graph is a conservative estimate of compressive critical loads on high stroke length U-Series actuators. We rate the U-Series to a maximum mechanical load of 500 lbf.



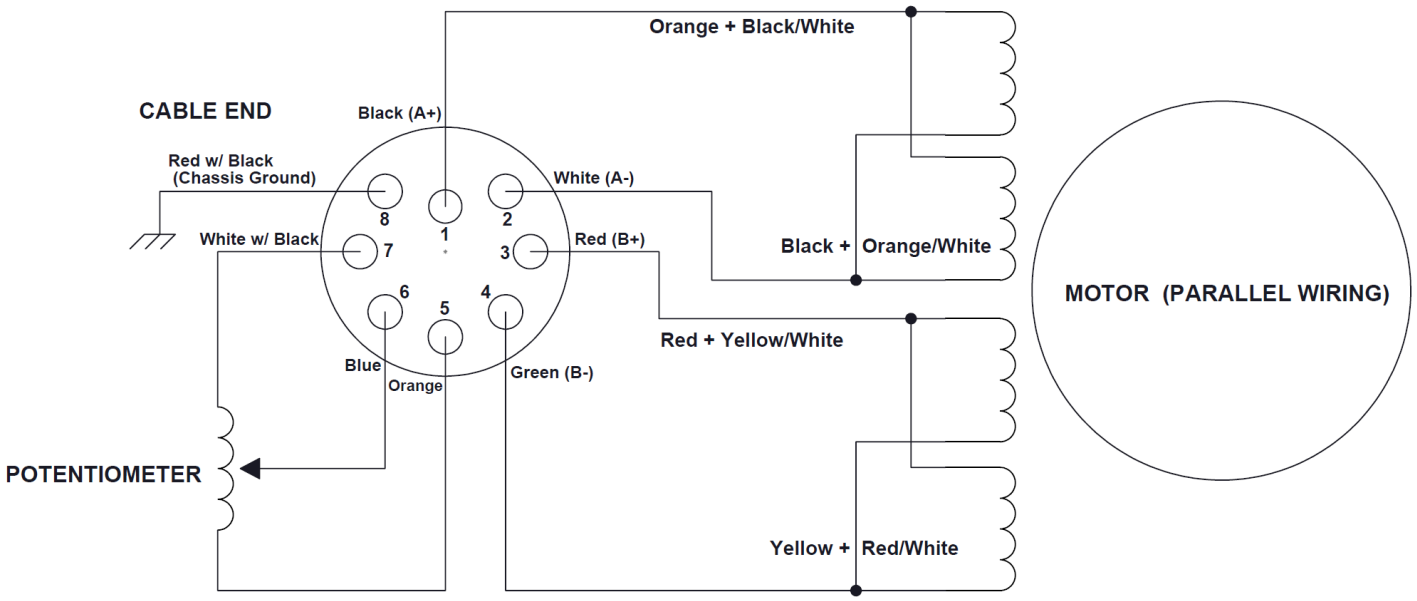
Linear Potentiometer Feedback

The internal linear potentiometer is intended to be used as a voltage divider. A voltage is applied across the V+ and V- terminals in order to generate a signal voltage at the wiper.The maximum suggested energizing voltage is 50 VDC, with 5 VDC to 10 VDC being more typical. The resolution of the linear potentiometer will be a function of your systems analog to digital converter.

Linearity of the potentiometer will be ±2%

Stroke Length	Potentiometer Resistance (±20%)
1” Stroke	1.15 kΩ
2” Stroke	3.0 kΩ
4” Stroke	5.5 kΩ
8” Stroke	10.5 kΩ
14” and 16”	20.0 kΩ
All Others	10.0 kΩ

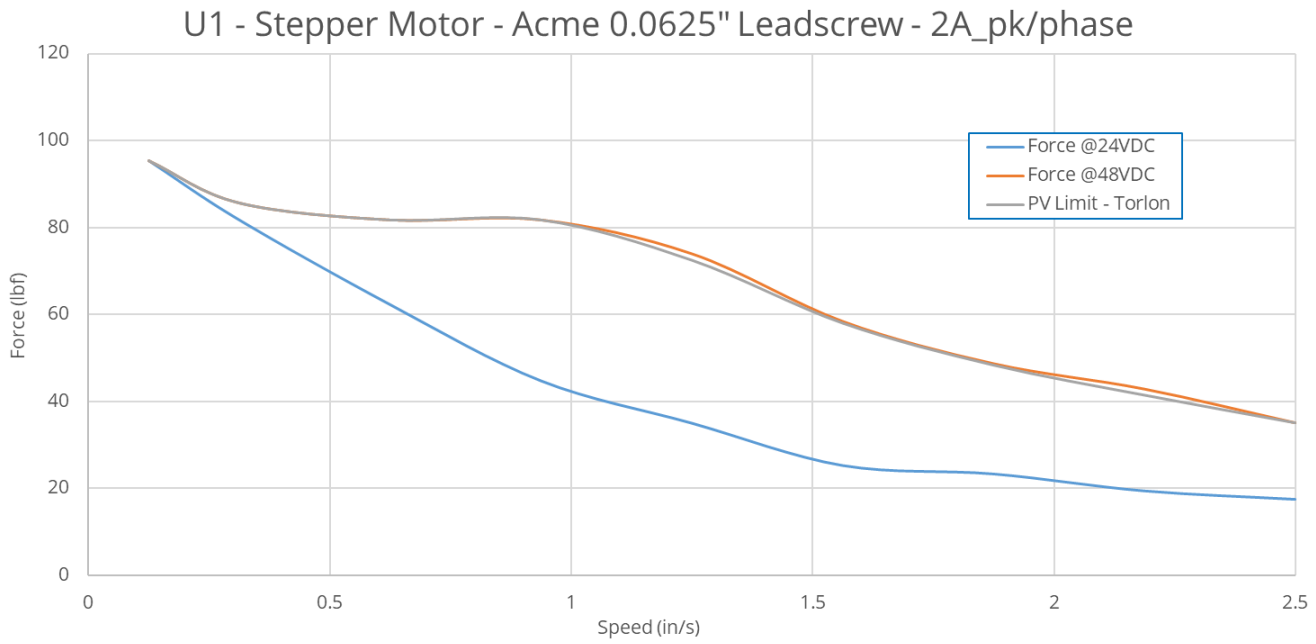
Below is the U-Series stepper motor pinout that includes the linear potentiometer for reference.

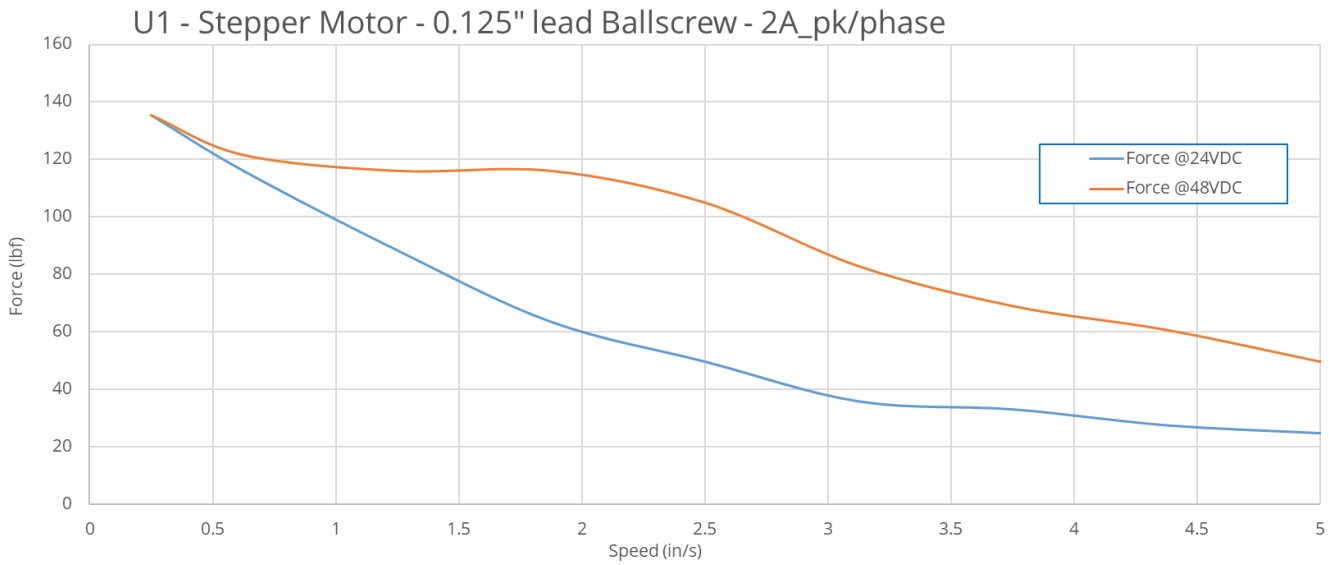


The Stepper Motor U-Series is the standard offering from Ultra Motion and is ideal for applications requiring high resolution positioning, high force at low speeds, and simple operation. The stepper motor U-Series requires external control electronics to operate the motor with at least 1.7 A_rms/phase current capability for the U1 and 4.2 A_rms/phase for the U2. All U-Series stepper motor actuators are wired in parallel by default. The user should account for headroom on performance to reduce the chance of stepper motor stall in the application.

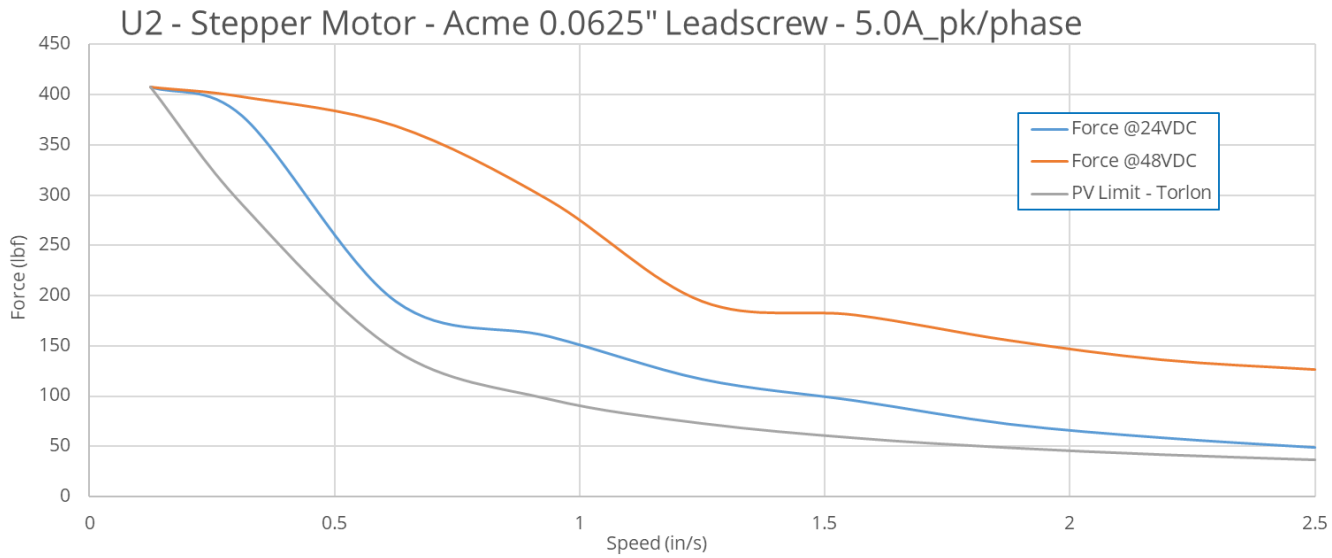
Contact Ultra Motion engineering for actuator performance with planetary gearheads or for non-standard series wiring.

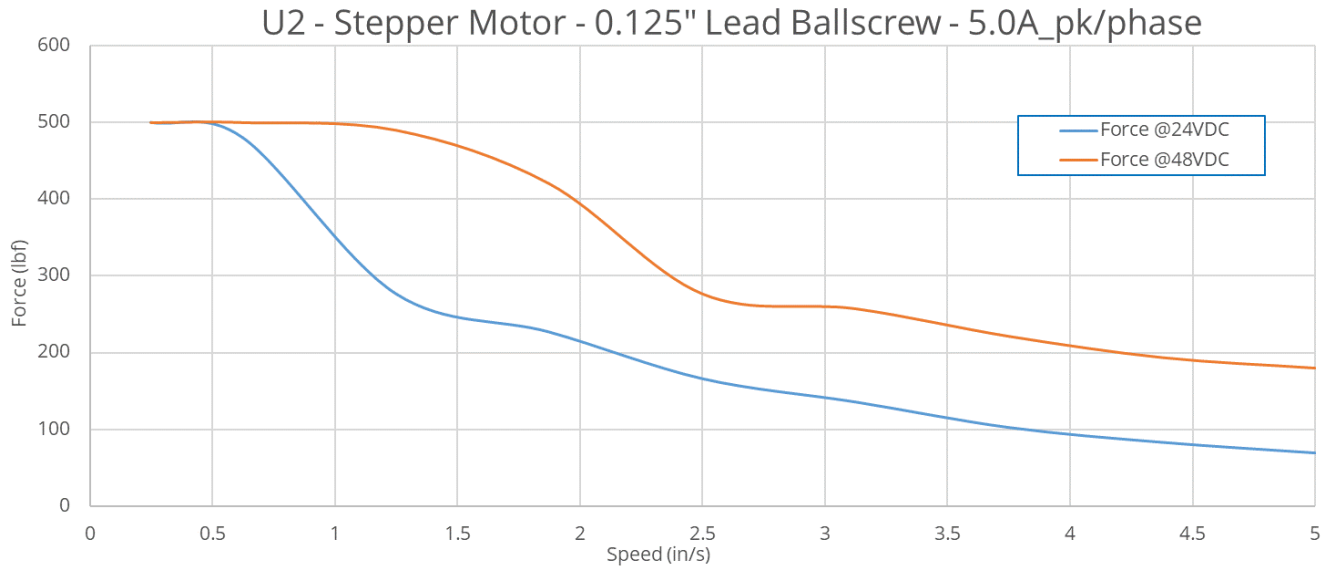
U1 Stepper Motor - Force vs. Speed





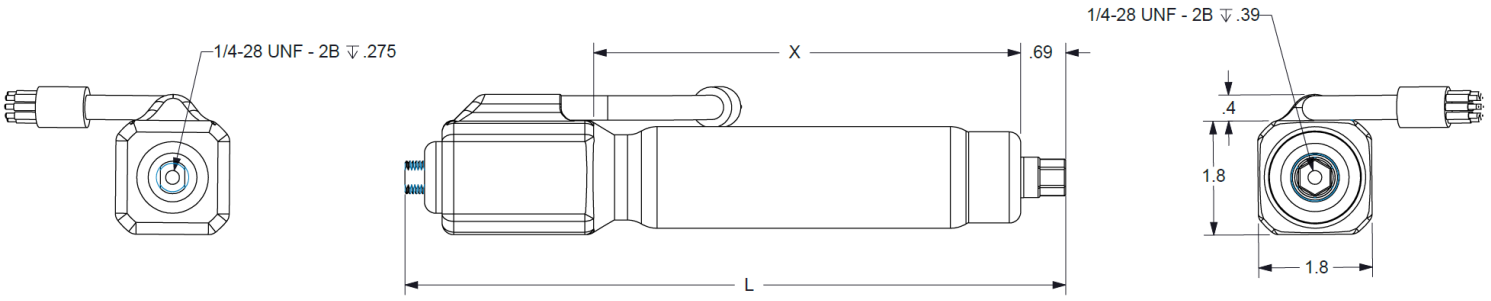
U2 Stepper Motor – Force vs. Speed





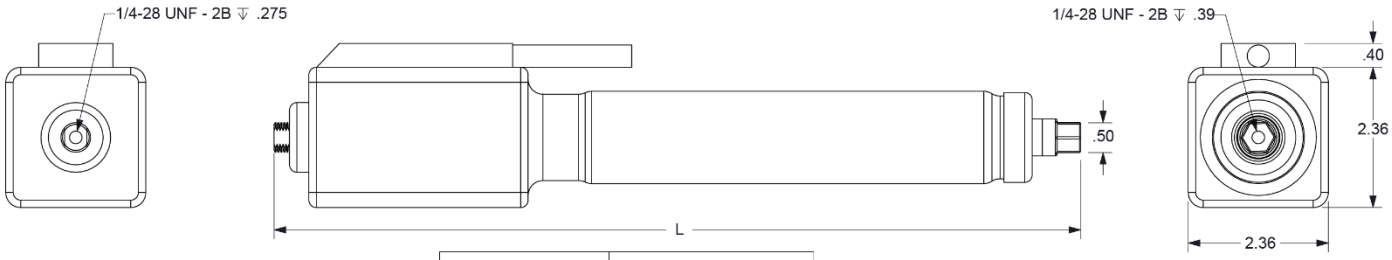
Note that the U-Series is rated for a mechanical maximum load of 500 lbf. The performance shown in the graphs above represents the continuous capability in air using an Applied Motion stepper motor controller.

U1 Stepper Motor Dimensions



STROKE LENGTH		RETRACTED LENGTH "L"		"X"	
INCHES	MM	INCHES	MM	INCHES	MM
2	50.8	8.16	207.26	4.47	113.54
4	101.6	10.16	258.06	6.47	164.34
6	152.4	12.16	308.86	8.47	215.14
8	203.2	14.16	359.66	10.47	265.94
10	254	18.16	461.26	14.47	367.54
12	304.8	20.16	512.06	16.47	418.34
14	355.6	24.16	613.66	20.47	519.94

U2 Stepper Motor Dimensions

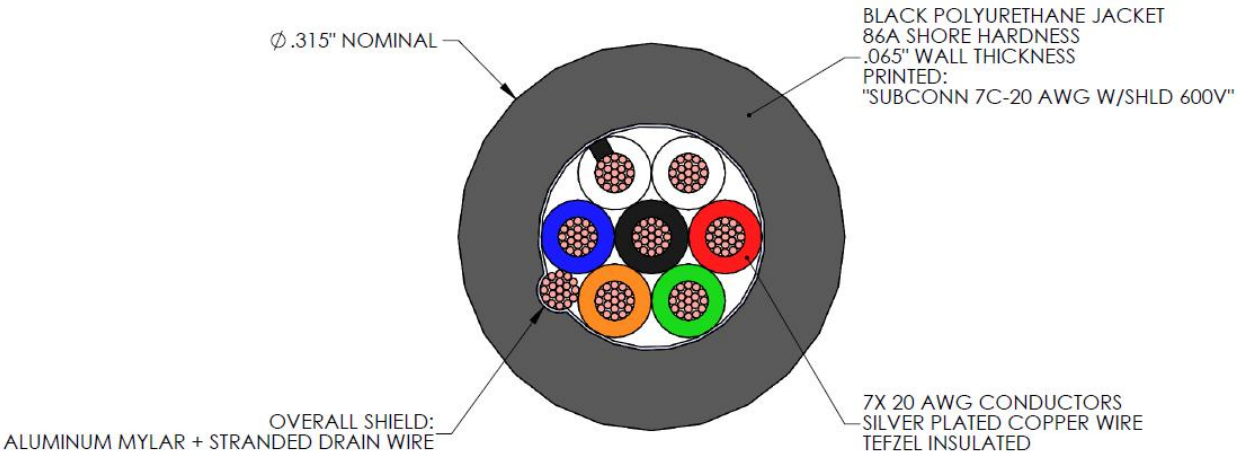


STROKE LENGTH		RETRACTED LENGTH "L"	
INCHES	MM	INCHES	MM
2	50.8	9.48	240.8
4	101.6	11.48	291.6
6	152.4	13.48	342.4
8	203.2	15.48	393.2
10	254	19.48	494.8
12	304.8	21.48	545.6
14	355.6	25.48	647.2

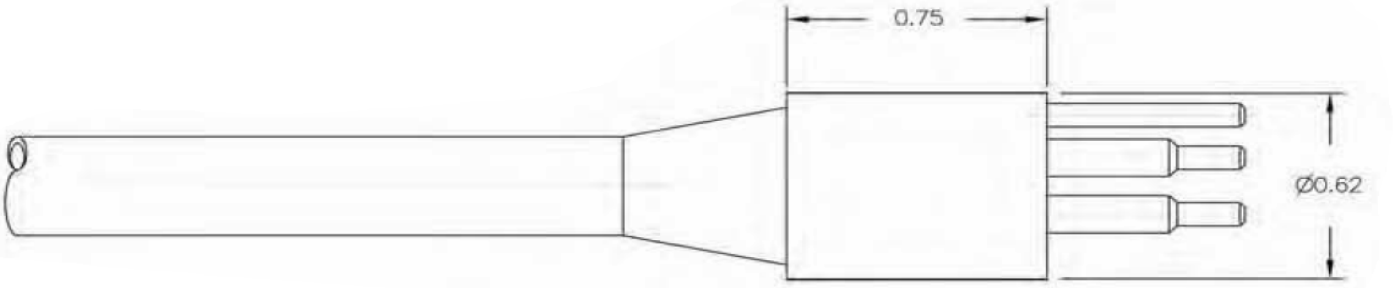
Contact Ultra Motion for 3D models

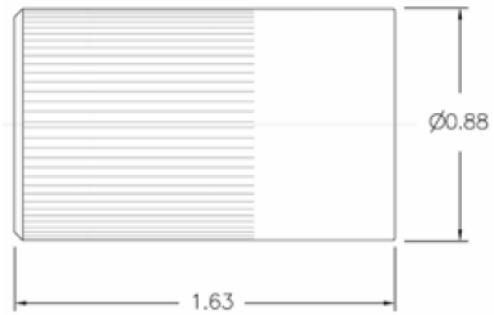
U-Series Stepper Motor Cable Details

The standard cabling for the U-Series stepper motor actuators is a 2 foot whip terminated with a SubConn MCIL8M connector and MCDLS-F locking sleeve.



	No.	Function	Color
Stepper – MCIL8M	1	A+	BLACK
	2	A-	WHITE
	3	B+	RED
	4	B-	GREEN
	5	POTENTIOMETER V-	ORANGE
	6	POTENTIOMETER SIGNAL	BLUE
	7	POTENTIOMETER V+	WHITE W/BLACK
	8	CHASSIS/SHIELD	DRAIN

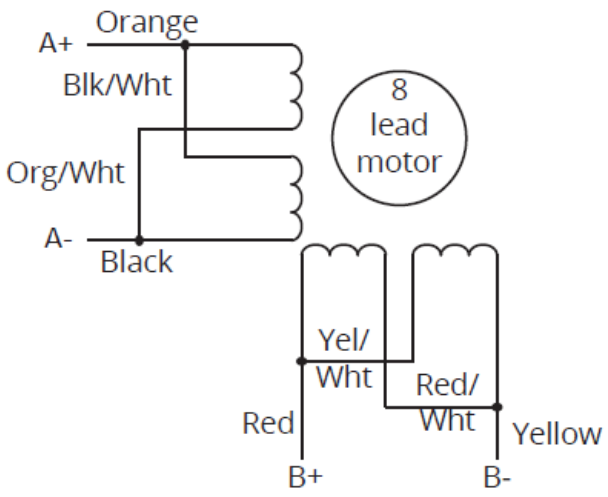




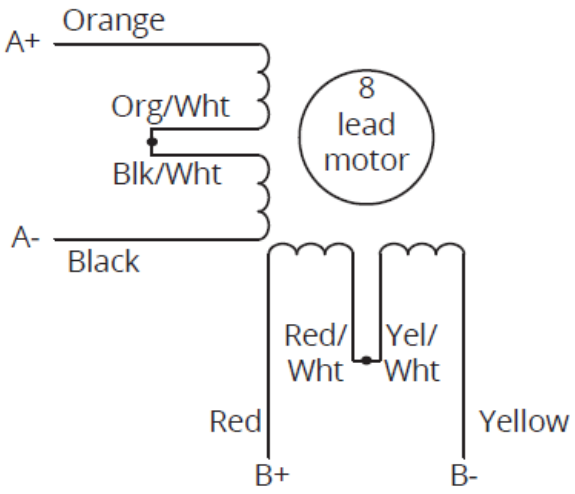
Contact Current Rating:	5A/contact (max 20A/connector)
Insulation resistance:	> 200 Mohm
Contact resistance:	< 0.01 ohm
Cable Jacket & Overmold Material:	Black Polyurethane
Locking Sleeve Material:	Black Delrin
Locking Sleeve Snap Ring Material:	AISI 302 Stainless Steel

Note that all U-Series actuators will be configured for parallel winding standard. Contact Ultra Motion to discuss a non-standard series winding arrangement.

Parallel Wire Configuration



Series Wire Configuration



$$\text{Steps Per Inch} = \frac{\text{Steps per Rev}}{\text{Lead}} \times \text{Belt Ratio}$$

$$\text{Encoder Cycles Per Inch} = \frac{\text{Steps per Rev}}{\text{Lead}} \times 500$$

$$\text{Quadrature Counts Per Inch} = \frac{\text{Steps per Rev}}{\text{Lead}} \times 2000$$

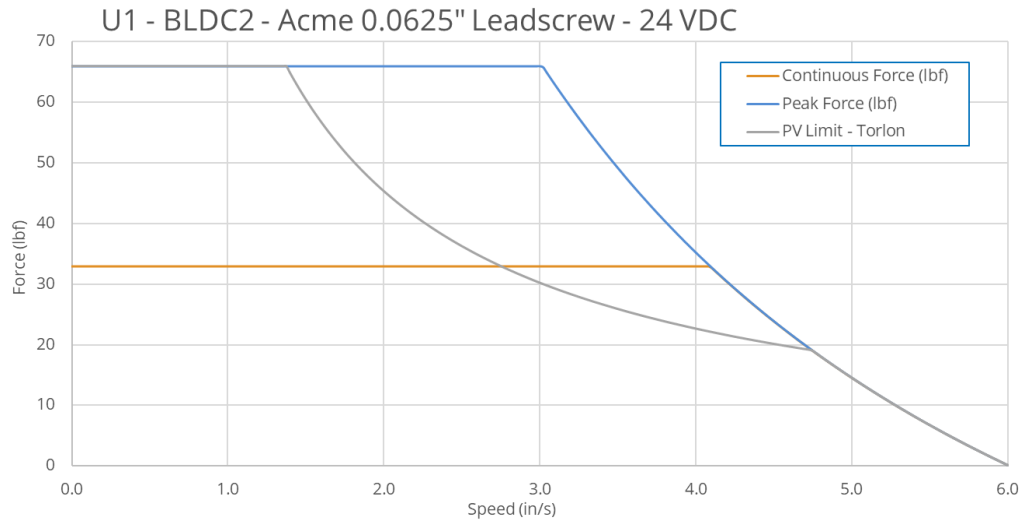
Maximum Current: B2, D1, U1	Series	0.85A RMS
	Parallel	1.70A RMS
Maximum Current: B3, D2, U2	Series	2.12A RMS
	Parallel	4.24A RMS

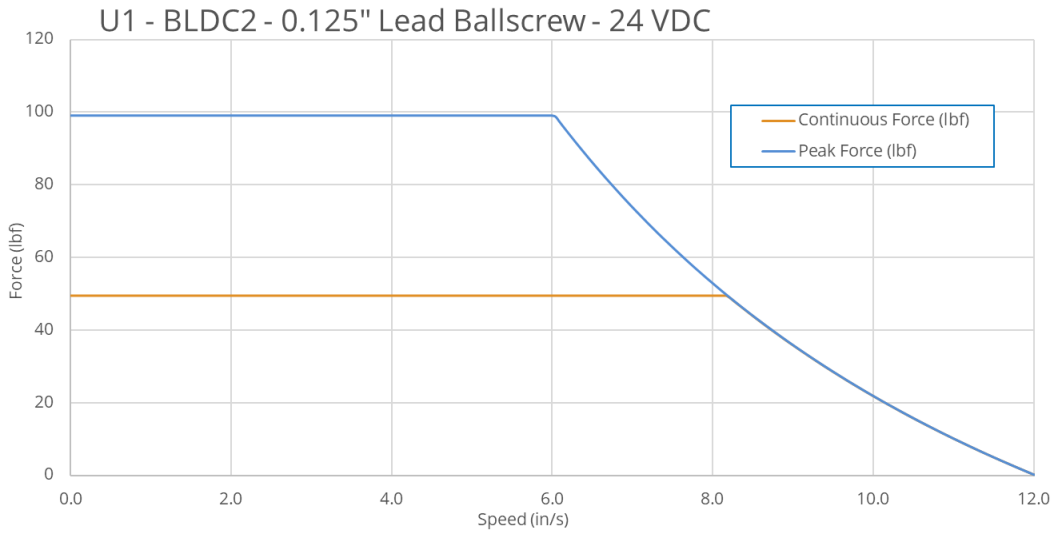
The brushless DC motor options for the U-Series offer higher dynamic capability and performance over a larger range of speeds when compared to the stepper motor actuators. The BLDC U-Series include Hall effect sensors for commutation and will require external BLDC drive electronics to operate. The coarse Hall effect commutation feedback makes the BLDC U-Series less suitable for high resolution positioning applications, but the increased dynamic capability makes them useful for control surfaces on subsea vehicles. The closed loop commutation also makes the BLDC U-Series important for applications that can have large peak hydrodynamic load scenarios where an open-loop commutated stepper motor may lose synchronization and stall. Linear potentiometers are standard on all U-Series actuators

Planetary gearheads can be incorporated into the BLDC line of U-Series actuators allowing for high force, low speed, closed loop commutated actuation.

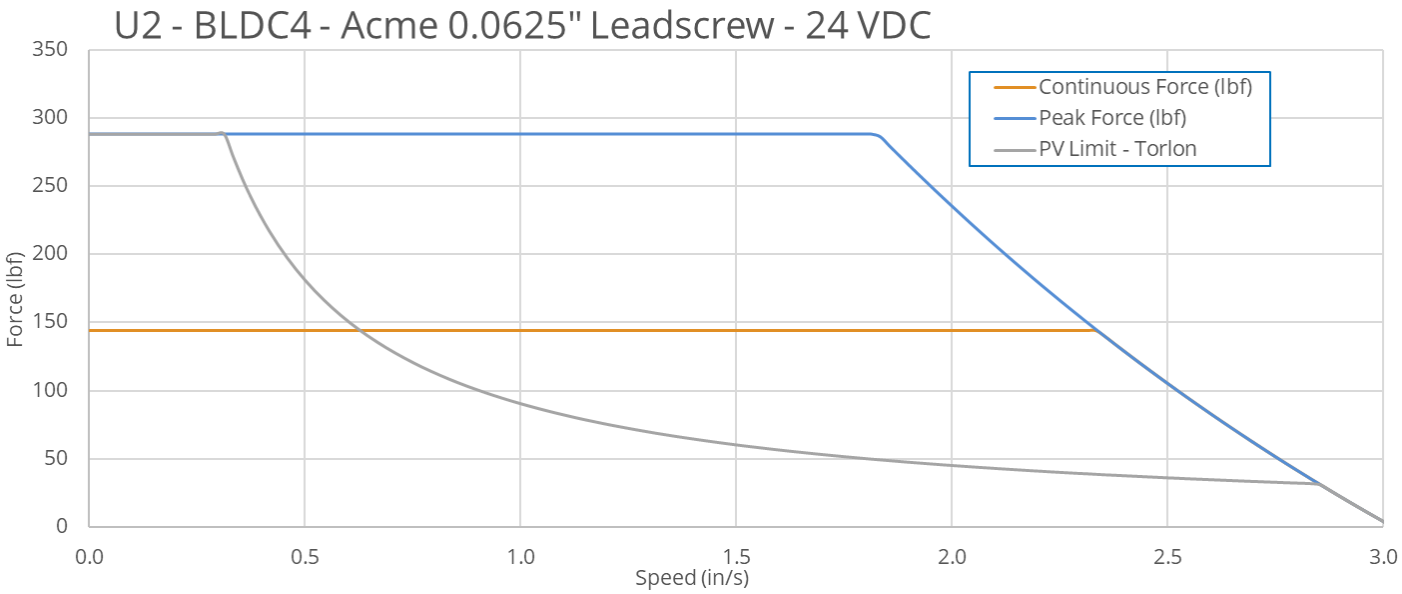
As in all applications, avoid contacting the internal mechanical hardstops of the actuator. Driving into external/internal mechanical hardstops with a BLDC actuator can lead to overheating of the motor if the control electronic's current limit is set above the continuous current rating of the actuator.

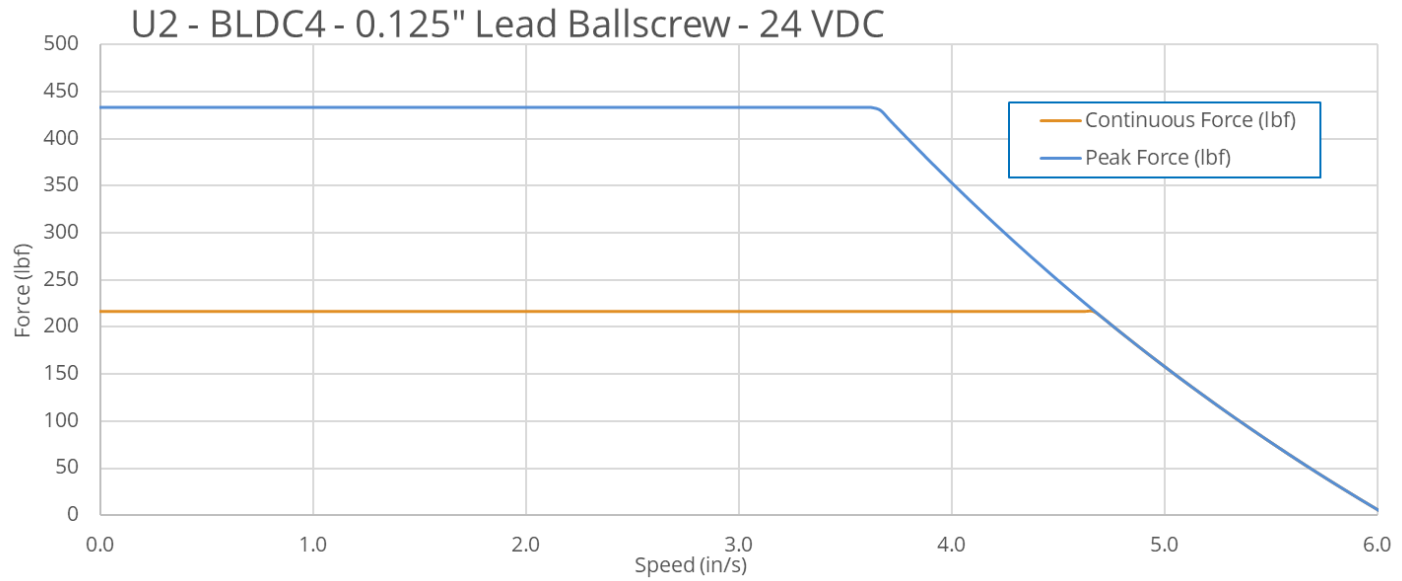
U1 BLDC Motor - Force vs. Speed





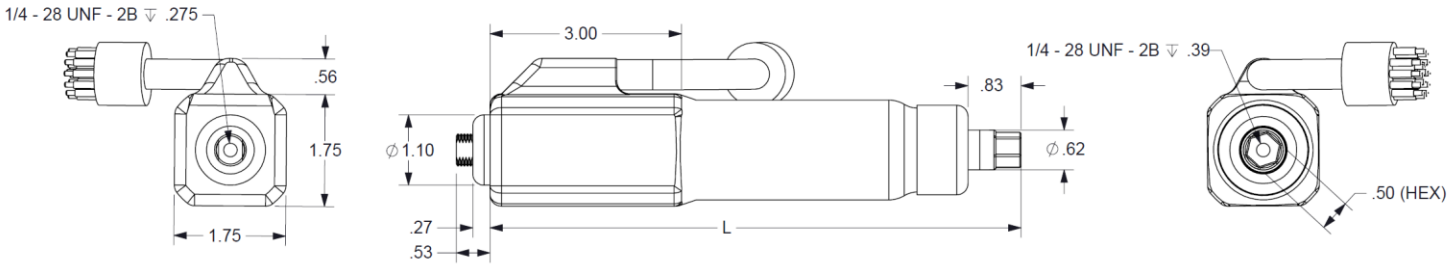
U2 BLDC Motor - Force vs. Speed





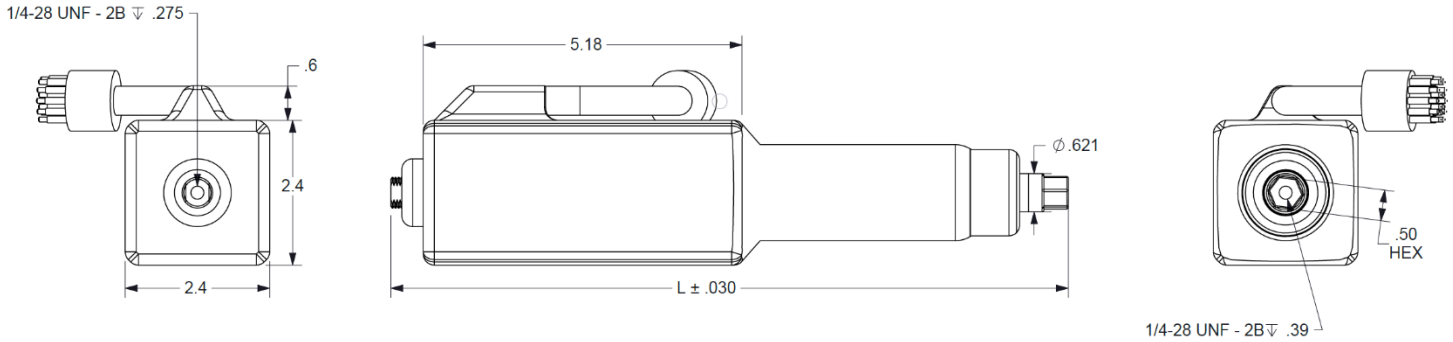
The continuous force in these performance graphs represents the load at which 100% duty cycle is allowable in air. The peak force is set to twice that of the continuous force as a reference.

U1 BLDC-2 Motor Dimensions



STROKE LENGTH		RETRACTED LENGTH "L"	
INCHES	MM	INCHES	MM
2	50.8	8.32	211.3
4	101.6	10.32	262.1
6	152.4	12.32	312.9
8	203.2	14.32	363.7
10	254	18.32	465.3
12	304.8	20.32	516.1
14	355.6	24.32	617.7

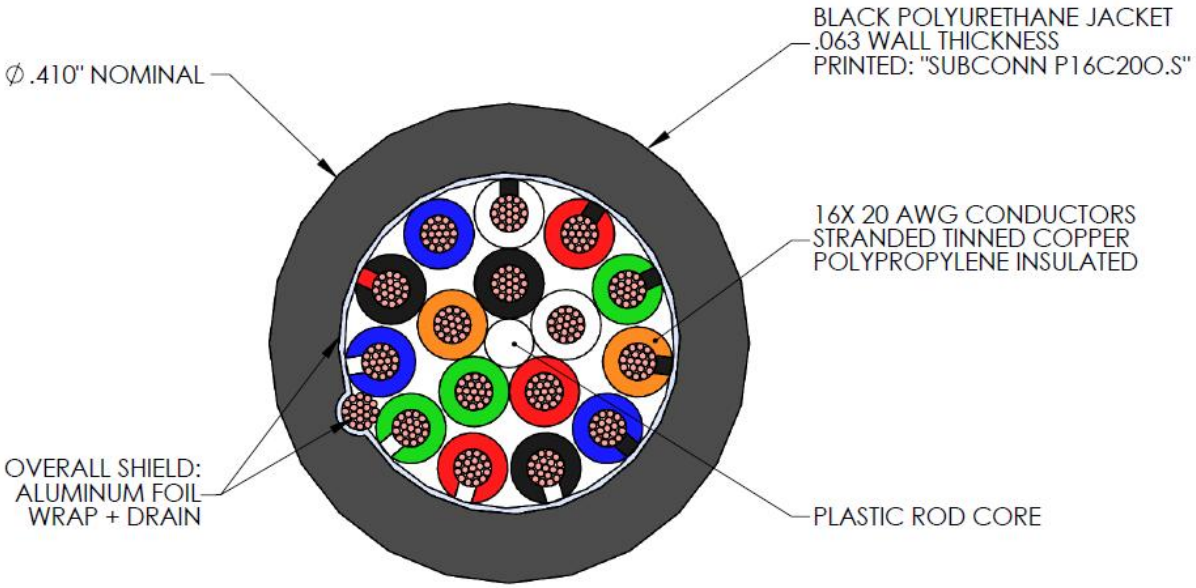
U2 BLDC-4 Motor Dimensions

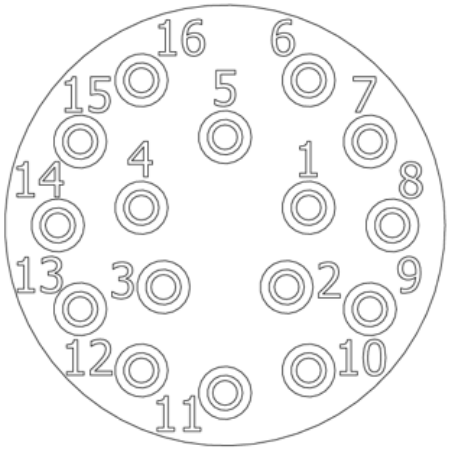


STROKE LENGTH		RETRACTED LENGTH "L"	
INCHES	MM	INCHES	MM
2	50.8	11.02	279.91
4	101.6	13.02	330.71
6	152.4	15.02	381.51
8	203.2	17.02	432.31
10	254	21.02	533.91
12	304.8	23.02	584.71
14	355.6	27.02	686.31

U-Series BLDC Motor Cable Details

The standard cabling for the U-Series brushless DC motor actuators is a 2 foot whip terminated with a SubConn MCIL16M connector and DLSA-F locking sleeve.

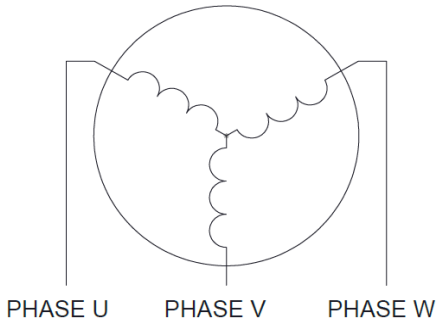




	No.	Function	Color
BLDC – MCIL16M	1	Phase W	BLACK
	2	Hall W	WHITE
	3	Phase V	RED
	4	Hall V	GREEN
	5	Phase U	ORANGE
	6	Hall U	BLUE
	7	NC	WHITE/BLACK
	8	NC	RED/BLACK
	9	CHASSIS	GREEN/BLACK
	10	Pot V+	ORANGE/BLACK
	11	NC	BLUE/BLACK
	12	Hall V-	BLACK/WHITE
	13	Hall V+	RED/WHITE
	14	NC	GREEN/WHITE
	15	Pot Signal	BLUE/WHITE
	16	Pot V-	BLACK/RED

U1 BLDC-2 Motor Electrical Parameters

STAR CONNECTION DIAGRAM



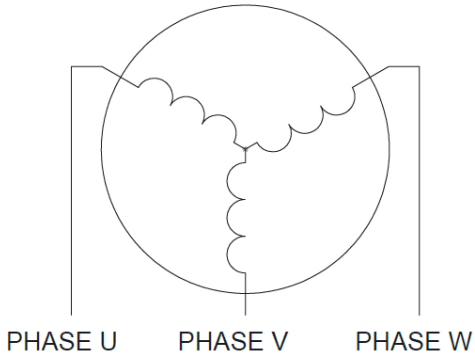
COMMUTATION SEQUENCE

ROTATION	HALL A	HALL B	HALL C	PHASE U	PHASE V	PHASE W
CW ↓	1	0	0	L	X	H
	1	1	0	X	L	H
	0	1	0	H	L	X
	0	1	1	H	X	L
	0	0	1	X	H	L
	1	0	1	L	H	X

MOTOR SPECIFICATIONS U1 BLDC-2	
NUMBER POLES	8 POLES (4 POLE PAIR)
NUMBER OF PHASES	3
HALL ANGLE	120
LINE TO LINE RESISTANCE	0.8 OHMS
INDUCTANCE	1.2 mH
CONTINUOUS RATED CURRENT (IN AIR)	3.6 A
RATED VOLTAGE	24 VDC

U2 BLDC-4 Motor Electrical Parameters

STAR CONNECTION DIAGRAM



COMMUTATION SEQUENCE

ROTATION	HALL A	HALL B	HALL C	PHASE U	PHASE V	PHASE W
CW ↓	0	0	1	X	H	L
	0	1	1	H	X	L
	0	1	0	H	L	X
	1	1	0	X	L	H
	1	0	0	L	X	H
	1	0	1	L	H	X

MOTOR SPECIFICATIONS U2 BLDC-4	
NUMBER POLES	4 POLES (2 POLE PAIR)
NUMBER OF PHASES	3
HALL ANGLE	120
LINE TO LINE RESISTANCE	0.49 OHMS
INDUCTANCE	1.33 mH
CONTINUOUS RATED CURRENT (IN AIR)	6.86 A
RATED VOLTAGE	36 VDC

U-Series Part Number Configuration

Model Number Structure

This example ordering code given here describes a U1-Series actuator with 0.125 inch/rev ballscrew, Nema 17 stepper motor with parallel winding, 8 inch stroke, internal linear potentiometer, ¼" spherical rod end bearings on both ends. All U1 actuators will use Nema 17 motors and gearheads, while U2 actuators will use Nema 23.

Example Ordering Code:

D-B.125-HT17P-8-P-RBC4/RBC4-UW

Ordering Code / Model Number

D	B.125	HT17P	8	P	RBC4	RBC4	UW
Series	Screw Option	Motor Option	Stroke Length	Internal Linear Potentiometer	Base Mount	Shaft Mount	Series

Series:

- **D:** The series designator for all U-Series actuators will be the character 'D'

Screw:

- **A.063**: 0.0625 inch/rev self-locking Acme leadscrew
- **B.125:** 0.125 inch/rev high efficiency ballscrew, backdriveable

Motor:

- **HT17P:** Nema 17 stepper motor, parallel winding, U1
- **LE513:** Nema 17 double-stack BLDC-2 motor, U1

- **HT23P:** Nema 23 stepper motor, parallel winding, U2
- **LE527:** Nema 23 quad-stack BLDC-4 motor, U2

*Consult Ultra Motion for planetary gearhead options

Stroke:

- 2", 4", 6", and 8" standard
- 1" to 16" available in whole number increments

Linear Potentiometer:

- **P:** Standard and required

Base and Shaft Fitting Options

- **4:** ¼-28 threaded hole
- **M6:** M6-1 threaded hole
- **RBC4:** ¼" spherical bearing
- **EC4:** ¼" eye clevis
- **ST4:** ¼-28 threaded stud

Series End:

- **UW:** The final designation in the part number for U-Series actuators will be -UW

Contact Information

If you have any questions about any of our other products, contact us by one of the following methods:

INQUIRY

Leave a web inquiry (to be replied to within one business day):
ultramotion.com/contact

LIVE CHAT

Live Chat directly with one of our engineers:
ultramotion.com

EMAIL

Email (to be replied to within one business day):
info@ultramotion.com

CALL

PH: 888-321-9178
Fax: 631-298-6593

ADDRESS

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HOURS

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Monday-Friday
9AM – 5PM EST