RS-485 CONTROLLED UNDERWATER POSITIONERS

MODEL PT-25FB-24VDC-RS-485
MODEL R-25FB-24VDC-RS-485

OPERATING AND MAINTENANCE MANUAL

SERIAL NUMBER: _____

SALES ORDER: _____

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20-02245 REV E

APPLICATION NOTE

INTERCONNECTING RS-485 CONTROLLED COMPONENTS

1. INTRODUCTION

ROS has introduced versions of our most popular underwater products that are controlled via RS-485 serial communication. This application note describes our recommendations to produce the best results when interconnecting products that share the same power and serial data communication lines.

2. OBJECTIVE

The objective of this application note is to guide the system designer so that he or she obtains the best results when networking any of the ROS products listed in section 3. When networking video devices, the system designer must consider their sensitivity to electrical noise. Products such as the SmartLight can produce small levels of electrical noise that is exacerbated over long cable lengths.

3. LIST OF ROS UNDERWATER RS-485 PRODUCTS.

To satisfy customer needs, ROS has developed turn-key net workable underwater products. Each of the products listed below has an integral RS-485 electronic driver. One of the main advantages of RS-485 serial communication is the ability and ease of networking of several products over a bus line.

- RS-485 CE-X-18:1, miniature color zoom camera
- RS-485 INSPECTOR, color zoom camera
- RS-485 PT-10, pan & tilt
- RS-485 PT-25, pan & tilt
- RS-485 Atlas high torque pan & tilt
- RS-485 SmartLight, high intensity LED lamp

4. RS-485 NETWORK

RS-485 is currently a widely used communication interface for data acquisition and control applications where multiple nodes intercommunicate. In other words, multiple RS-485 loads/nodes can be interconnected via a single serial communication bus line. ROS has adopted RS-485 half duplex, 8-bit data, one stop bit, no parity, no hardware flow control, and 9.6/19.2/57.6 kbps as standards.

5. ELECTRICAL NOISE

Electrical noise can be problematic if it causes visual interference in monitors, video cameras, computers, and other devices. Electrical noise compounds when several devices share the same conductors for their power source. Electrical noise is generally caused by motors, switching power supplies, lamps, computers, ignition systems, alternators, etc.

ROS pan & tilts use motors, and the SmartLight emulates a switching power supply; therefore, these devices intrinsically create some electrical noise. ROS has gone to great lengths to design our products with state-of-the-art electrical noise filtering circuits. Even with these circuits, some residual noise may be generated.

Any video camera that shares power conductors with other devices should be considered the most susceptible to electrical noise; in this configuration, lines or patterns that are not associated to the viewed scene may be displayed on the video monitor.

6. POWER SOURCE

All ROS RS-485 products are designed to be powered with DC voltage only. It is essential that power delivered to any VDC device be free of electrical noise. Switching power supplies are among the most common power source devices, due to their size and efficiency. Unfortunately, these switching power supplies can be the source of electrical noise and may mislead the system designer or user to inappropriately attribute the noise to a device attached to the power conductors. It is recommended to ensure that the ripple noise of the power supply's specification sheet not be greater than 250mVpk-pk.

The system designer must calculate the maximum power consumption of the entire network, and that the power supply exceeds such power. For example: if the entire network draws 50W then it is recommended that the power supply exceeds the power drop by at least 10% (55W). When the power source exceeds the network power consumption it guarantees power to each device.

7. CABLES AND WIRES

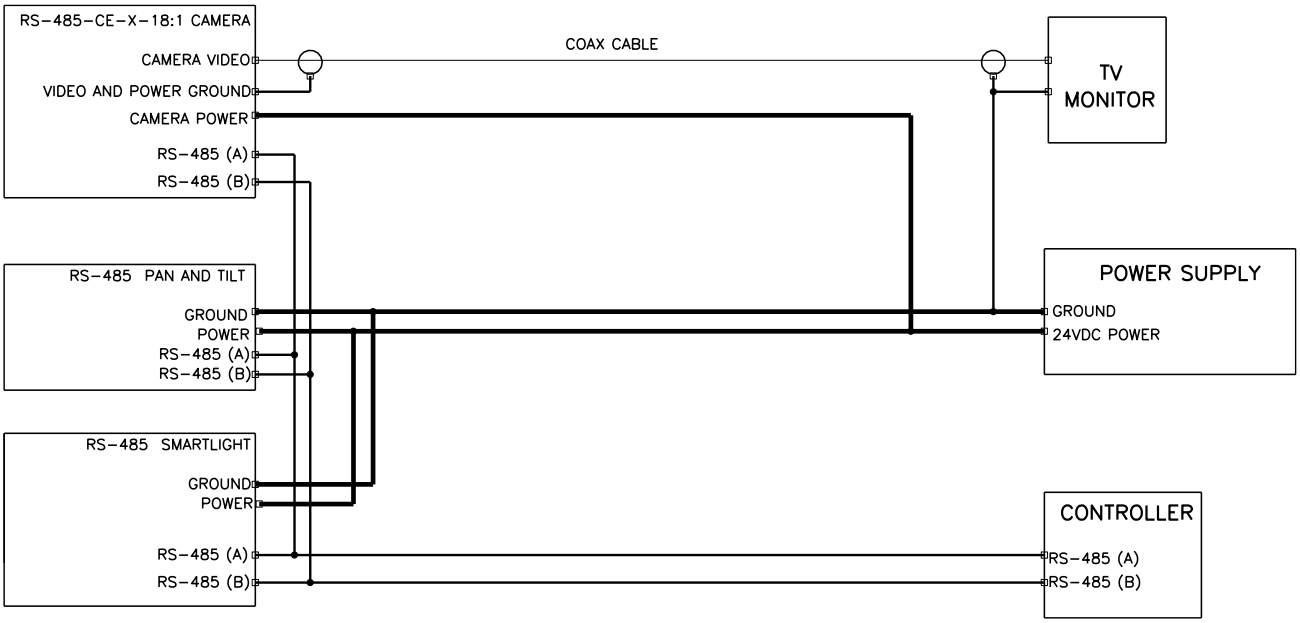
When selecting a cable for both the system power and RS-485 communication, the system designer must consider: cable length, wire gauge, power drop, and power source.

As described in section 6, the power source must exceed the maximum power required by the network. Also note that cable length effects system voltage drop; the system designer must compensate for this voltage drop. For example: an RS-485 pan & tilt can be attached to one end of a 100' cable, with a 24 VDC power supply on the other. By specification, the minimum voltage required by the pan & tilt is 20 VDC. If the wires within the cable are 26AWG, there could be a 5 VDC voltage drop over the cable's length. In that case, the pan & tilt would only receive 19 VDC at its connector, which is less than the minimum voltage required by the device.

8. POWER NETWORK CONNECTIONS

When a video camera is attached to the network, it is crucial that common power connections are made at the power supply end of the cable (see figure 1). It is highly recommended to provide a separate pair of power conductors whenever a video camera is connected to the network. When just pan & tilts are connected to the network, using two conductors as power bus lines is generally sufficient because those devices are not as susceptible to electrical noise.

When a video camera is connected to the network and common power connections are made at the cable breakout (hardware side) instead of the power supply end, any possible electrical noise caused by the switching circuits within devices like a SmartLight or a pan & tilt will be displayed on the video signal. Since video circuits are sensitive to electrical noise, all power and ground conductors must be terminated at the power supply end. This will ensure that any electrical noise generated by a SmartLight, pan & tilt, or other device will be routed to source ground.



REVISION PAGE

REV	DESCRIPTION	DATE	INITIALS
A	Added Application Note page	8/16/06	SW
B	Added R-25FB-24VDC-RS-485	12/12/06	RJL
C	SEE ECO #1251	07/14/08	GR
D	SEE EC-00605	02JUL10	BAL
E	SEE EC-01190	18JAN13	SW

WARRANTY

Remote Ocean Systems, Inc (hereinafter called "**ROS**") warrants its products as slated below to the conditions specified.

ROS warrants its products, when operated under normal conditions, to be free from defects in material or workmanship for a period of one year from the date of purchase provided that inspection by **ROS** discloses that such defects developed under normal and proper use. **ROS** products repaired or replaced pursuant to this warranty shall be warranted for the unexpired portion of the warranty applying to the original product. The liability of **ROS** under this warranty shall exist subject to the following conditions:

(a) **ROS** is properly notified of such defects by Purchaser, and the defective product is returned to **ROS**, transportation charges paid by Purchaser.

(b) **ROS** shall be released from all obligations under its warranty in the event repairs or modifications are made by persons not authorized by **ROS**.

(c) Representations and warranties made by any person, including distributors and representatives of **ROS**, which are inconsistent or in conflict with the terms of this warranty, shall not be binding upon **ROS** unless reduced to writing and approved by an officer of **ROS**. **ROS** shall in no event be liable for other direct, special, incidental, consequential, indirect or penal charges.

(d) This warranty shall be governed by the laws of the State of California.

In the event the defect is determined to be within the terms of this warranty, then **ROS** agrees to repair and/or replace (at **ROS**'s discretion) the product of defective portion at no charge to the Purchaser. This warranty does not apply to expendable items or to normal wear and tear and is conditional upon performance of normal preventative maintenance procedures.

Our commitment to quality and customer service directs us to constantly strive to improve our products. The materials and specifications presented in our manuals and data sheets are correct and accurate to the best of our knowledge, and are presented in good faith. However, the information is not guaranteed and is subject to change without notice.

LIMITATION OF REMEDIES

Purchaser assumes all risk and liability for results obtained in any installation, operation, or use of the product. Purchaser's sole remedy for any breach of warranty by vendor shall be limited to the "express remedies" set forth above. Otherwise, in no event shall vendor, its agents, or employees be liable to the original purchaser or third party for any consequential or incidental damages or expenses of any nature arising directly out of or in connection with the use of vendor products, even if vendor has been advised of the possibility of such damages or expenses. In any event, unless otherwise contrary to state law, vendor liability under this limited warranty shall not exceed the purchase price of the product.

CUSTOMER ASSISTANCE

ROS, Inc. uses a worldwide network of stocking distributors and representatives who are familiar with our products and are able to provide assistance during installation and/or operation of these products.

If you have any questions or problems with this product that are not covered by this manual or instruction, please contact our agent in your area or contact us directly by phone or fax or E-mail.

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INTRODUCTION

This publication describes the ROS model PT-25(FB)-24VDC-RS-485 Pan and Tilt and the R-25(FB)-24VDC-RS-485 rotator. These positioners utilize brushless stepper motors and integral electronic stepper motor drivers. The positioners are designed for operation from a 24 volt dc source. Control functions are achieved through a standard RS-485 2 wire Half Duplex communications configuration.

Both positioners are offered as air filled units, for shallow applications or in air operation, or as oil-filled pressure compensated units suitable for deep-water applications.

For problems or questions not covered in this manual, please contact the factory or one of our authorized representatives.

ROS Inc, reserves the right to change or modify designs or specifications as part of its continuing product improvement program.

NOTE:

Positioner operation is normally under operator control from a remote computerized control unit. A separate manual (21-30022) is provided that has details on the interfacing and protocol required for operation.

GENERAL DESCRIPTION

The model PT-25(FB)-24VDC-RS-485 Pan and Tilt and the R-25(FB)-24VDC-RS-485 rotator are designed to remotely orient underwater, or in-air, TV and photographic cameras, lights, acoustic equipment, and other instrumentation. It is designed to handle moderate to heavy payloads. Please refer to the torque curves in this manual for torque/speed data.

The housing, end plates, and all machined internal components of the positioners are made of 6061-T6 aluminum, which is hard anodized for corrosion protection. The units are also optionally available with stainless steel or titanium housings for applications in highly corrosive environments. Other external hardware such as screws and retaining rings are made of stainless steel.

The drive train for the positioners use reversible brushless stepper motors coupled to the output shaft through low backlash harmonic gear assemblies. The output gear of the harmonic reducer is bolted directly to the output shaft. The output shaft is supported by stainless steel ball bearings.

The motor drive technology used in the positioners is that of a unipolar stepper. Motor rotation on the positioner is controlled by a small Printed Circuit Assembly (PCA) mounted to the shaft plate. The circuit board receives the +24VDC (nominal) input voltage from an external remote Controller and generates the step sequence necessary to drive the stepper motor.

To operate the positioner, the user can send either a rotate command or an absolute position command. The unit has a range of speeds available for rotation. Position commands can be sent within a 0-360 degree range. Position moves are done according to a speed profile which has adjustable acceleration/deceleration, maximum velocity, and braking. In braking mode, a current is maintained through a winding of the motor in order to prevent the output drive shaft from moving due to external mechanical loads.

An additional safety feature of the positioner is slip/stall detection. If an axis stalls during acceleration or slips due to an overly heavy load, the axis will detect and brake at the last commanded braking value.

If the positioner is oil-filled, the pressure housing shall be compensated by use of a Bellofram. This provides a slight positive internal pressure to minimize shaft seal drag and potential leakage problems due to hydrostatic pressure. The oil serves to provide continuous lubrication as well as cooling to the internal components.

Electrical connection is made through an underwater mateable connector (LPMBH-4-MP). This connector has a right-angle configuration to minimize the swept-out volume requirements of the positioner.

SPECIFICATIONS

PERFORMANCE

Power, Operating Mode	24 VDC @ 1.7 Amps maximum per axis
Braking Mode	24 VDC, Adjustable, 220 mA ≤ Brake Current ≤ 1.2A ±0.2A per axis
Maximum brake load	57 lbs/ft @ maximum brake current of 1.2A
At Rest (not braking)	< 100 mA
Control Protocol	
Type	RS-485, 2 wire half duplex, 8 bit data, 1 stop bit, no parity, no hardware flow control,
Flow Control	Character Echo, Adjustable communication delay for use with a wide range of converters
Command Protocol	ROS RS-485 Positioners (Document 21-30022)
Supported Baud Rates	Factory Set to 9.6 kbps, 19.2 kbps, or 57.6 kbps
Feedback (optional)	Absolute position, ± 0.5 degrees precision
Absolute Position Move	+/-1 degree (including feedback resolution)
Scan Range	0-360 degrees pan / tilt / rotator
Acceleration Settings	2,4,6,8, or 10 deg/s^2
Rotation Speed Range	0.5 to 10 ±0.1 degrees/sec. (0.083 to 1.66 RPM) in 0.5 degree/sec increments
Torque	33 lbs/ft (14 Nm) minimum @ 5 degree/sec
Harmonic Gear Backlash	36 arc minutes (0.6 degrees)
Network-Ability	Up to 32 ROS RS-485 nodes sharing the same cable for power and communication
Safety Mechanism	Slip/stall detection

MECHANICAL

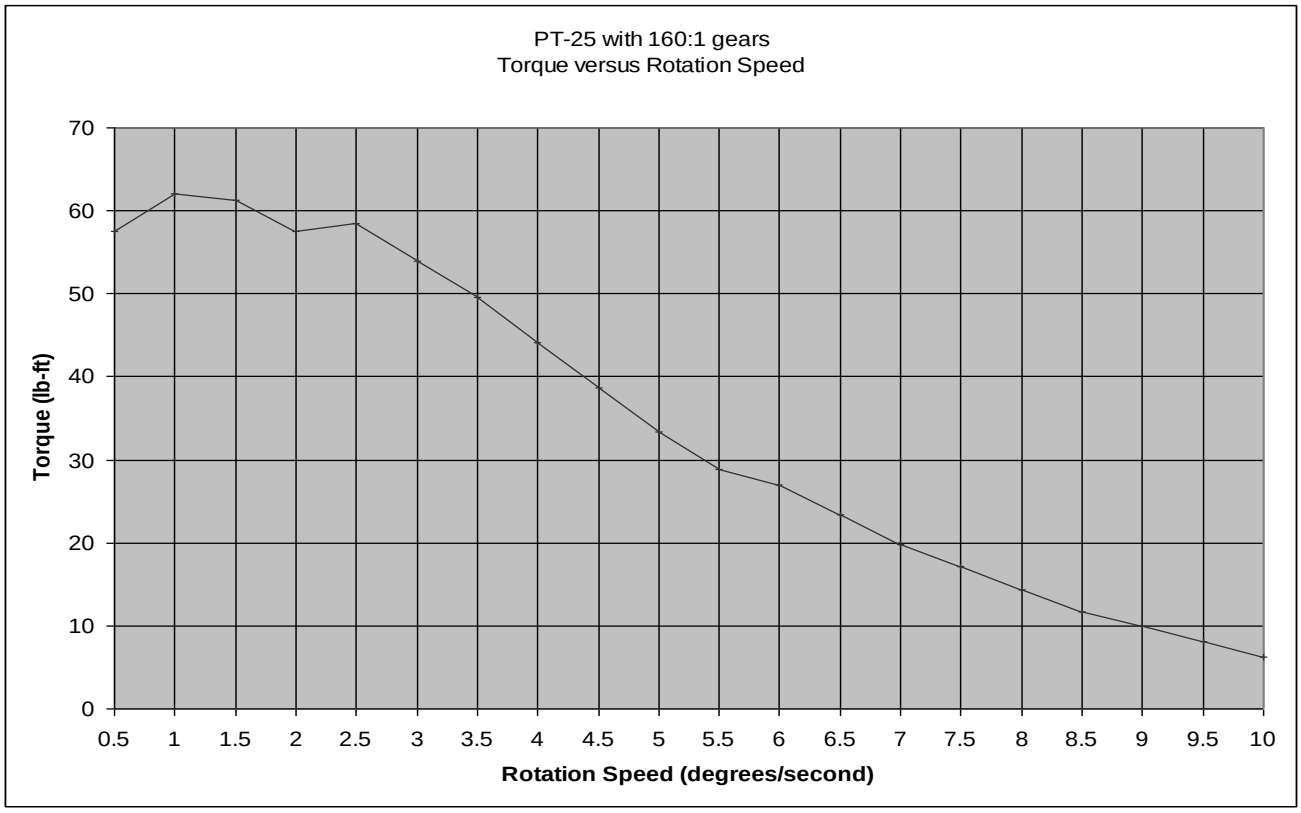
Dimensions and weights	see Installation Outline drawings
Housing Material	6061-T6 Aluminum
Housing Finish:	Hard Black Anodize
Standard Connector	4 pin connector (2 pins for power, 2 for RS-485)
Positioner Connector	LPMBH-4-MP OR 5507-1508
Mating Connector	LPMIL-4-FS OR 5501-1508 respectively
Equipment Mounting	Four 3/8-16 threaded holes on output shaft
Mounts	Mounting plate (recommended).
External Mechanical Limits	External stop collar (recommended). Yoke bracket, optional (recommended).

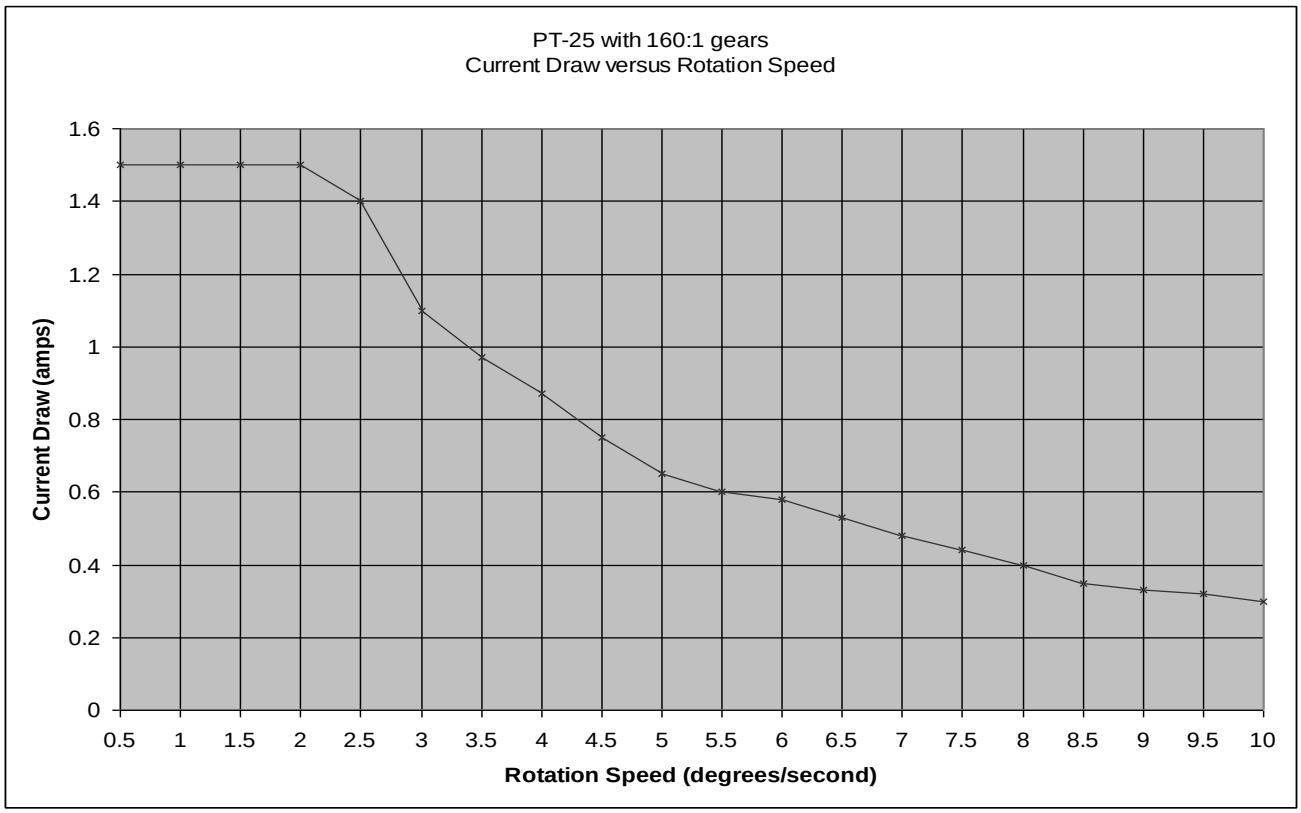
NOTE: If no yoke bracket is used, be sure to have mechanical stops to prevent the shaft from rotating past 0 or 360 degrees. Rotating past the factory setting will damage the potentiometers and disable feedback.

ENVIRONMENTAL

Depth Rating

Air-Filled	30 m (100 ft.)
Oil-Filled	3,000 m (9,842 ft)
Operating Temperature	0°C to +50°C (-4°F to 140°F)



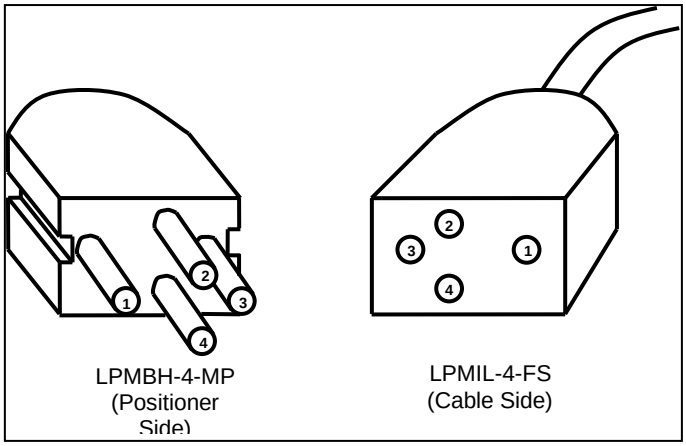


TORQUE CURVES

CONNECTOR WIRING

The standard connector pin functions for the four-contact LPMBH-4-MP as well as the eight-contact 5507-1508 underwater connectors are shown below. Alternate customer specified connectors and wiring standards are available, and details of these configurations are normally included in the manual Addendum.

CONNECTOR PIN	CONNECTION-FUNCTION
1	DC Common
2	+24 VDC
3	RS-485 A
4	RS-485 B



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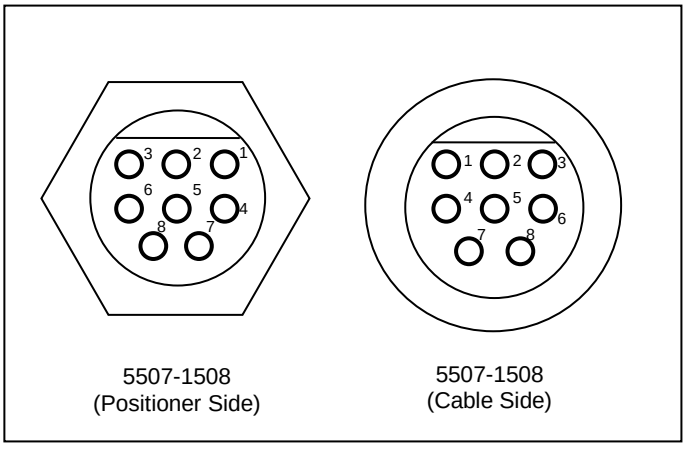


INSTALLATION AND OPERATION

When you receive your RS-485 positioner, carefully unpack it and inspect for any shipping damage or, if oil-filled, any oil leakage. Please contact the factory immediately if damage is noted.

OPERATIONAL CHECK

After unpacking your positioner, an operational check should be made prior to installation of the unit. The following procedure is recommended:

1. Place the positioner on a table with the connector up.

2. Make sure controller power is turned off.

3. Apply a small amount of silicone spray lubricant to the mating connector and carefully attach it to the bulkhead connector.

4. Attach the other end of the cable assembly to the controller or other control system and operate the unit while observing the output shaft.

5. If any problems are noted, please contact the factory immediately.

INSTALLATION

The RS485 positioners can be operated in any attitude. The unit is installed by mounting the positioner to a permanent structure. Four 3/8-16 tapped holes are provided in the mounting boss for the rotator and pan and tilt. Feedback units should be mounted to a MP-2 mounting plate. The MP-2 mounting plate mounts to the pan output shaft and utilizes six .390” diameter mounting holes on a 5.0” bolt circle. This allows for mechanical hard stops that protect the feedback pots should the unit be accidentally forced past its soft stops. Reference the Installation Outline drawing for your specific positioner.

EQUIPMENT MOUNTING

Four 3/8-16 tapped holes in the output shaft are provided for this purpose. A standard mounting plate as described above is available from ROS, and special mounting clamps and saddle brackets can be provided if necessary.

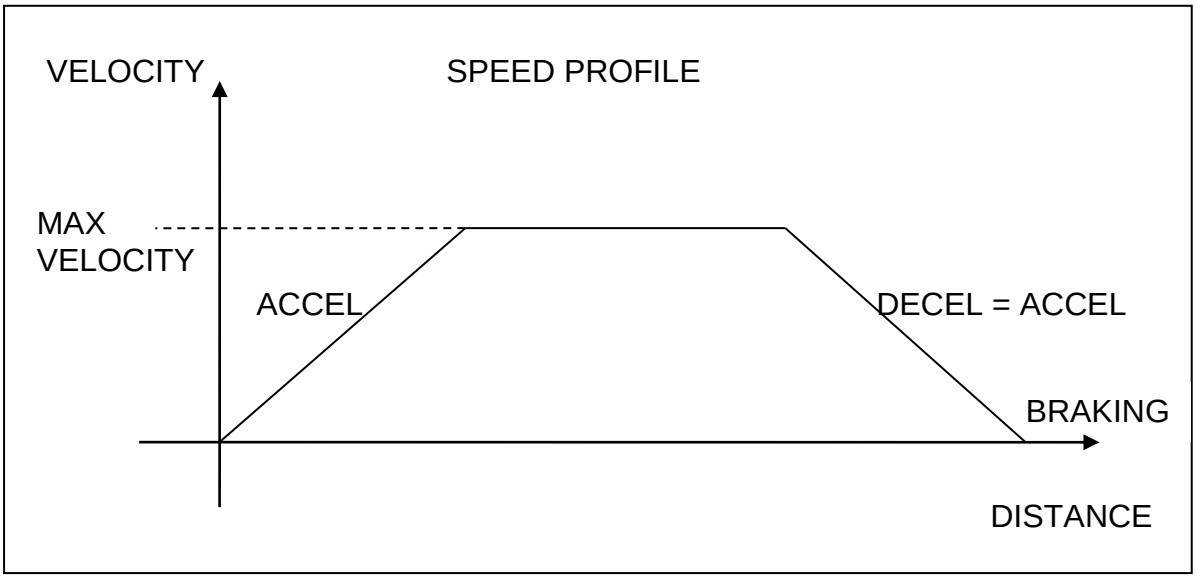
The RS485 controlled positioners were designed to handle reasonable payloads commensurate with the torque curve. Equipment size, weight, distance from the center of axis, undersea current drag, and forces due to equipment cables are all factors that should be considered when mounting the equipment. Some general guidelines are as follows:

1. Mount equipment as close as possible to the output shaft. This minimizes bearing drag forces on the axis.

2. Mount the equipment so that the center of gravity is close to the center of axis to minimize torque requirements. In some cases it is advantageous to add counterweights to achieve a more balance configuration.

3. When possible, minimize cross sectional area of the equipment that will be exposed to hydrodynamic drag forces.

CONTROLLING THE UNIT



Refer to the communication protocol (21-30022) for controlling your pan-and-tilt. Movement on each axis will follow a path similar to the figure above when ramping commands are used. The user can send rotate or position commands to move each axis. To operate the pan-and-tilt without stalling or slipping, the user should calculate the amount of torque required to hold the load on each axis. Then, once this is known, the user should refer to the torque curve to find the maximum velocity that can be achieved without a stall occurring. For example, if the user knows their maximum load is 20 lbs. at a foot (requiring 20 ft-lbs.), the axis should not move faster than 6.5 degrees/sec. The user should not send rotate commands faster than 6.5 degrees/second and the maximum velocity of the position speed profile should be adjusted to 6.5 degrees/sec. This will limit the maximum velocity on position moves only. The axis will brake at the last commanded braking value. Set the braking value according to the torque curve. The user can also adjust the acceleration.

INTERCONNECTION

Interconnection is made through the underwater connector. To mate the connector, **TURN POWER OFF**, clean both halves of the connector, lubricate the mating connector lightly with silicone spray, and push together.

The other end of the cable attaches to a controller which provides the required power to the connector pins as well as control signals using RS-485 protocol. Details on this protocol are included in a separate manual (21-30022). Contact Customer Service personnel at ROS Inc., if further assistance is required.

MAINTENANCE

The RS-485 Controlled positioners were designed to provide a long lifetime of service with minimal maintenance.

If the positioner is oil-filled, the recommended routine maintenance is limited to checking the compensating fluid volume. For other maintenance, we recommend the positioner be returned to the factory. If this is not possible, field maintenance and repair should be limited to the procedures described in this manual. For unusual situations or if additional field maintenance is required, please contact the factory for assistance. The maintenance procedures covered in this manual are End Cap Removal and Replacement, Seal Replacement, and Motor Removal and Replacement and, if equipped with oil, Fluid Volume Checking.

FLUID VOLUME CHECK (If equipped with oil)

The unit is shipped from the factory containing approximately 45.3 fl oz of SAE 10 spindle oil. The compensator fluid volume should be checked periodically to assure that no fluid is leaking out of the unit due to worn seals, etc. This is done by a simple visual inspection of the Bellofram end of the housing. A protective cover with holes for water flow covers the Bellofram. When the fluid volume is normal, the Bellofram will expand outward. Its position can be checked by visual observation through the holes or by using a blunt probe (Q-Tip) inserted through the compensator cover. If fluid has leaked out, the Bellofram will become flat or recessed into the housing, and the unit should be recharged with fluid.

WORK AREA PREPARATION

Any work done on the internal parts of the positioner requires the unit to be opened. A clean work area should be prepared to avoid getting dirt or other debris on the seals or sealing surfaces, or inside the motor or precision harmonic gearing.

If the positioner is oil-filled, there is a high probability of spillage when the unit is opened. Additional fluid, Spindle Oil 10, should be available for refilling and towels should be available for cleaning.

END CAP REMOVAL

The end cap must be removed for any internal maintenance procedures.

CAUTION: If the unit is oil-filled, it is internally pressurized by the compensator Bellofram.

1. Oil Filled - Using a ¼-20 x 2 bolt with a nut and washer, withdraw the plunger to relieve the pressure on the Bellofram. Secure in withdrawn position. If not oil filled, skip this step and begin at step 2.

2. Carefully remove the two seal screws in the end cap. If the unit is oil-filled, allow the oil to drain out before continuing.

3. Remove the stainless steel ring, which retains the end cap.

4. Remove end cap, using a special end cap pulling tool, thread the two ¼-20 bolts into the seal screw holes.

5. Restrain the housing and output shaft and pull the end cap out of the housing and off the shaft.

For replacement of the end cap, refer to the **END CAP REPLACEMENT** section of this manual.

SEAL REPLACEMENT

Whenever the end caps are removed, the O-rings, quad seals, and Seelscrews should be replaced.

1. Remove the end cap as described above.

2. Remove the old O-ring and quad seal.

3. Clean O-ring and quad seal surfaces.

4. Apply a small amount of silicone grease or other O-ring lubricant to the new seals and install them in the grooves of the end cap. Avoid excessive stretching of the O-ring.

5. Using silicone grease or O-ring lubricant, completely fill the top retaining ring groove. If this is not done, the sealing O-ring may be damaged when the end cap is installed.
6. Position the end cap assembly into the housing without pressing it in. Push the end cap down until the O-ring is at the snap ring groove. Slowly continue to press the end cap into the housing. **DO NOT** apply forces to the end of the shaft. Install the snap ring and new Seelscrews.

If the unit is oil-filled and if the fluid is leaking near the compensator cover, the Bellofram should be inspected and replaced if damaged.

Carefully inspect the Bellofram for any tears or nicks, particularly in the vicinity of the sealing edge. Replace if damaged. Clean the sealing surfaces, apply a small amount of O-ring lubricant to these surfaces and the sealing surfaces of the Bellofram. Replace the Bellofram and compensator cover. Refill the unit with fluid, de-gas, and close.

MOTOR REMOVAL AND REPLACEMENT

The motors used in the RS-485 controller positioners are brushless stepper motors and are noted for very long lifetimes without maintenance. Before undertaking motor replacement, make sure that proper operating voltage is being provided by the controller and interconnecting cable. In the event that replacement of the motor is necessary, replacement of the motor as well as the associated control module PCA as an assembly is recommended.

1. Remove the end cap as previously described in **END CAP REMOVAL** and if oil-filled, drain the remaining compensating fluid.

2. Remove the zip ties and disconnect the JST connectors.

3. Remove the retaining ring, which secures the bearing plate.

4. Mark the output shaft with the housing for re-assembly. Grasp the output shaft and gently pull assembly from housing.

5. The motor plate, which attaches to the motor and the fixed harmonic gear, is now visible. Remove the retaining ring in the housing bore, which secures the motor plate assembly. Be careful not to scratch the inside of the housing with the ends of the rings, particularly in the vicinity of the O-ring sealing surfaces. Keep these rings separate from the outer rings, which retain the end cap. The outer rings are made of stainless steel for corrosion protection. If one of the retaining rings is “wavy”, note that it belongs closest to the motor.

The motor assembly is removed, in most cases, by inverting the housing and tapping it with a non-metallic hammer or other object. If this technique is used, be careful to protect the gear and motor assembly as it slides out of the housing.

6. When the motor assembly is removed, be careful that the locking pin is not lost. This normally remains attached to the inside wall of the housing.

If defective, the entire motor assembly including the motor plate and the attached gears should be returned to ROS for repair or replacement. If return is not possible, the motor, motor plate, and harmonic gear components must be disassembled to replace the motor.

IMPORTANT: Note the orientation of the flex spline of the harmonic gear assembly relative to the motor shaft before removing. During re-assembly, it must be mounted in the same position for proper operation and torque output of the gear mechanism.

7. **NOTE:** The position of the wave generator with respect to the motor shaft. Remove the retaining ring, which holds the wave generator to the motor shaft and remove this portion of the gear mechanism.

8. Remove the three flat head screws, which attach the motor plate to the motor assembly.

9. Replace the motor assembly.

10. Mount the new motor using a removable thread retainer and re-attach the wave generator to the motor shaft.

11. Clean exposed drive surfaces of the harmonic drive components and apply a liberal coating of high pressure, lithium-bearing grease to all components.

12. Make sure the keyway pin is in place and slide the motor assembly into position so that the key fits properly into the slot in the motor plate.
13. Replace internal retaining rings.

Replace the end cap as described in the **END CAP REPLACEMENT** section of this manual.

END CAP REPLACEMENT

IMPORTANT: Using silicone grease or O-ring lubricant, completely fill the top retaining ring groove with grease. If this is not done, the sealing O-ring will be damaged when the end cap is installed.

IF AIR-FILLED:

With the end cap seal screws removed, replace the end cap and slowly push it into the housing. It may be necessary to rotate the output shaft slightly for proper gear engagement. Install the retaining ring and replace the seal screws.

IF OIL-FILLED:

STANDARD BELLOFRAM:

With the shaft end up, fill the unit with compensating fluid to approximately one half inch from the top. Position the end cap assembly into the housing without pressing it in. Since fluid may be ejected through the seal screw holes, place a towel over the end cap to reduce the losses. Push the end cap down until the O-ring is at the snap ring grove. Replace the seal screws. Continue to press the end cap/shaft assembly in the housing bore and slowly push it into the housing. **DO NOT** apply large forces to the end of the shaft. If the harmonic drive does not want to mesh easily, it is helpful to slightly rotate the output shaft allowing the gear teeth to engage while applying moderate pressure to the end cap. Install the snap ring, which retains the end cap, and replace the seal screws located in the end plate.

SPRING-LOADED BELLOFRAM:

When the pan and tilt is sealed except for the pan axis, insert an appropriately sized screw with a nut on it into the hole in the compensator cover. Use the screw to draw the piston back and the nut to retain it thus relieving any pressure on the compensator. Add compensating fluid (Shell Spindle Oil or equivalent) to the level of the shaft snap ring groove.

IMPORTANT: Completely fill the top snap ring groove in the housing with O-ring lubricant. If this is not done, the O-ring on the end cap could be damaged by the snap ring groove and the unit will leak.

Position the end cap assembly into the housing without pressing it in. Since fluid may be ejected through the seal screws holes, place a towel over the end cap to reduce the losses. Push the end cap down until the O-ring is fully seated into the housing. Replace the seal screws. **DO NOT** apply large forces to the end of the shaft. If the harmonic drive does not want to mesh easily, it is helpful to slightly rotate the output shaft allowing the gear teeth to engage while applying moderate pressure to the end cap. Install the snap ring, which retains the end cap, and replace the seal screws. Remove the screw retaining the compensator piston. The unit will now been under positive pressure. It is recommended that the unit be observed for several hours to determine if there are any leaks.

APPENDIX

20-10218	Installation/Outline, PT-25
20-02238	Assy, PT-25FB-24VDC-RS-485-AIR-AL, 160:1 Gears
20-02246	Assy, PT-25FB-24VDC-RS-485-OIL-AL, 160:1 Gears
20-02247	Assy, PT-25FB-24VDC-RS-485-AIR-SS, 160:1 Gears
20-02216	Wiring Diagram, PT-25FB-24VDC-RS-485
20-10004	Installation/Outline, R-25DC-FB, AIR
20-10035	Assy, R-25FB-24VDC-RS-485-AIR-AL, 160:1 Gears
20-10005	Installation/Outline, R-25DC-FB, OIL
20-10036	Assy, R-25FB-24VDC-RS-485-OIL-AL, 160:1 Gears
20-10037	Wiring Diagram, R-25FB-24VDC-RS-485
21-30022	Protocol, RS-485 Communication