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BULLETIN
BUL-055

Pronto4™ Steering Ring Manual

Background

The patent-pending Pronto4™ Agnostic Autonomy System creates optionally unmanned systems in less than four hours on any existing vehicle or vessel that uses a steering wheel or skid steer for control. This universal, existing vehicle autonomy kit can be attached to most sets of human operated controls where a man sits when operating a ground or surface vehicle. A vehicle outfitted with a Pronto4 system has the ability to be driven by computer or by man without removal of the system. No additional training is required for a vehicle operator to climb in and take control. Actuation has been reduced to a flexible set of attachments that can be configured to meet the different, but highly common human control paradigm.

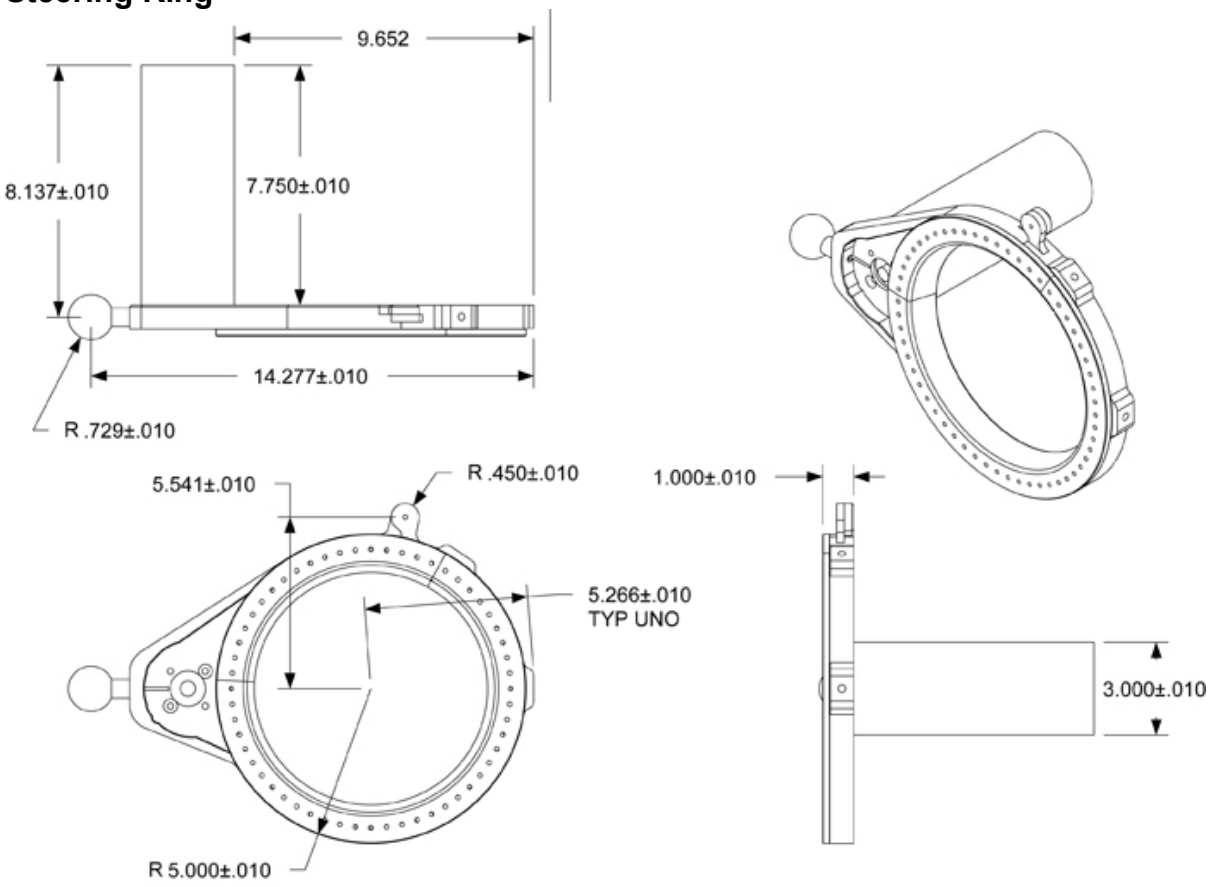
Introduction

This document provides information for the Pronto4 Steering Ring. All measurements are in inches with an accuracy of +/- .01 inches.

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Steering Ring

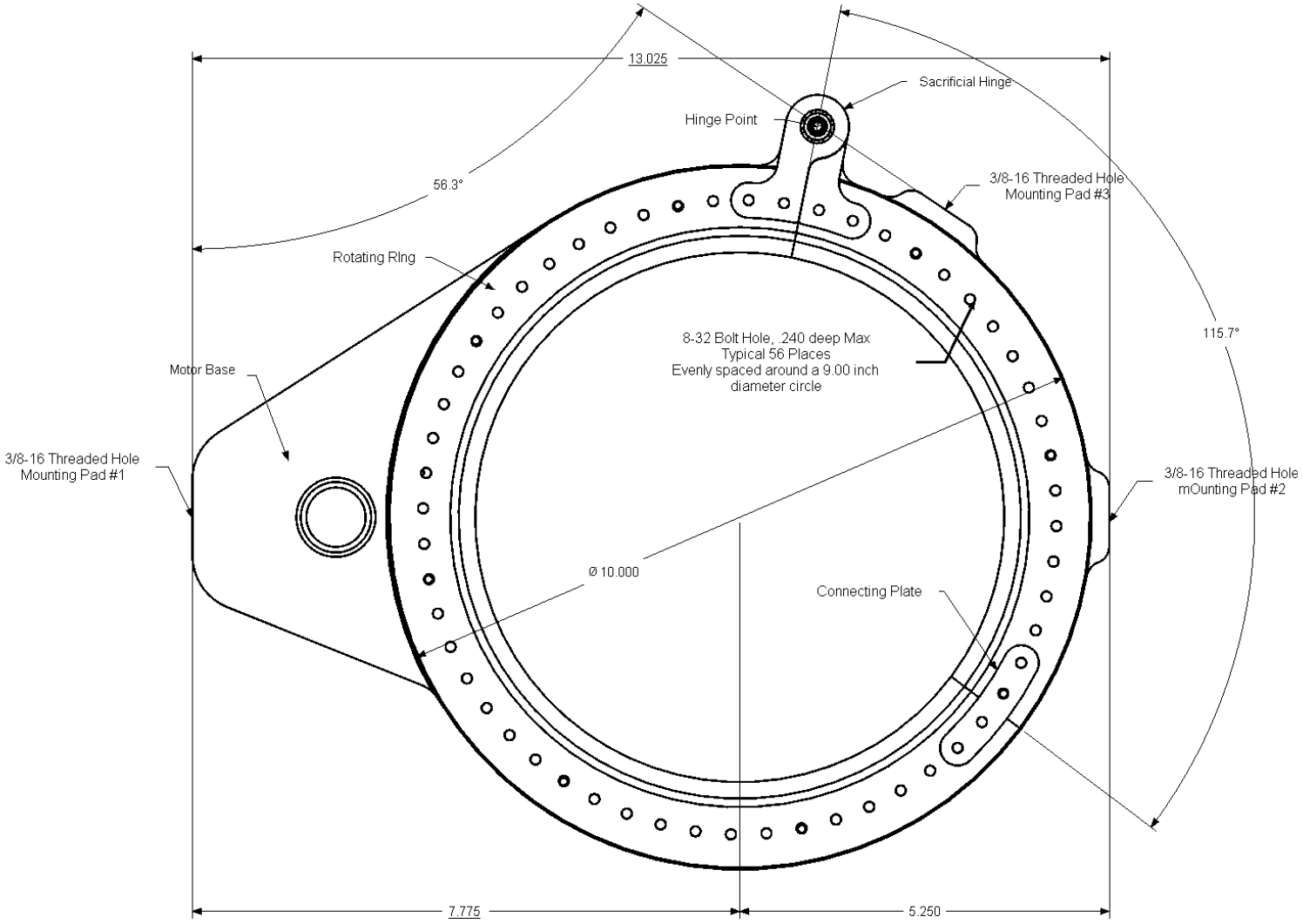


The Pronto4 Steering Ring is a multi-function mechanical actuator designed to adapt to most steering wheels in Ackerman steering based vehicles. The steering ring opens about a hinge point such that the steering column or steering wheel of the vehicle does not usually need to be removed. The steering ring is captive around the steering column rigidly attached to the steering wheel. The rotational steering actuator is biased to the vehicle with a single post. The steering actuator is driven by the CAM and is electrically connected through a pair of cables – power and signal.

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The drawing below shows some of the important features and additional measurements of the Pronto4 Steering Ring.



Mounting Pads	These three points are used to bias the rotational motion of the ring to the vehicle. In most cases just a single mounting pad is used, primarily pad 1. Mounting pad 2 and pad 3 provide additional support where higher steering force may be required.
Connecting Plate	The rotating ring separates into two components. This plate joins the two ring parts together
Rotating Ring	The steering wheel is attached to the rotating ring using clamps or Velcro of firm attachments. The opening created by separating the ring allows it to go around the steering wheel without removing it.
Hinge Point	When the steering ring opens it hinges about this point to allow clearance for steering column entry.
Motor Base	Attached to the back of the steering ring is a drive motor. This motor may be axial or radial mounted based upon installation requirements.

Components

The Pronto4 Steering Ring includes:

- 12vdc motor
- Planetary gear and chain
- Either a 14:1 or 7:1 gear reducer motor
- Two cables, one for power and the other for signal
- Quadrature encoder with analog limits for achieving the number of rotations desired
- Support pole and extension arms (or other steering wheel connection)

P/N: KA100-01-03, Pronto4 Steering Ring (14:1) Parameters

DC Motor Performance Parameters	Value	Units	Tolerance
Rated Voltage D.C.	@ 12.0	VOLTS	N/A
Rated Continuous Current	8.1	AMPERE	N/A
Rated Torque	50.0	OZ – IN	N/A
Rated Speed	2300	RPM	+/- 15%
Rated Continuous Power Out	85	WATTS	+/- 15%
No Load Speed	2600	RPM	MAX
No Load Current	0.82	AMPS	MAX
Back EMF Constant (Ke)	4.5	V/KRPM	+/- 10%
Torque Constant (Kt)	6.1	OZ - IN / A	+/- 10%
DC Armature Resistance at 1.5 Amps	0.60	OHMS	+/- 15%
Armature Temp	155	DEGR. C	MAX
Peak Torque (motor-only)	500	OZ - IN	N/A
Planetary Gearmotor Output Parameters	**Value**	**Units**	**Tolerance**
Planetary Gearbox Ratio	14:1	N/A	N/A
Gear Motor Rated Continuous Torque	33.0	LB-IN	MAX
Gear Motor Rated Peak Torque	213++	LB-IN	MAX
Gearbox Shaft Output Speed (@ F.L.)	164	RPM	N/A
Gearbox Standard Backlash	45	Arc - Minutes	MAX
Gearbox Efficiency	75%	N/A	N/A

Table 1: 14:1 motor parameters

P/N: KA100-01-162, Pronto4 Steering Ring (7:1) Parameters

DC Motor Performance Parameters	Value	Units	Tolerance
Rated Voltage D.C.	12.0	VOLTS	N/A
Rated Continuous Current	4.3	AMPERE	N/A
Rated Torque	50.0	OZ – IN	N/A
Rated Speed	1400	RPM	+/- 15%
Rated Continuous Power Out	52	WATTS	+/- 15%
No Load Speed	1650	RPM	MAX
No Load Current	0.52	AMPS	MAX
Back EMF Constant (Ke)	7.2	V/KRPM	+/- 10%
Torque Constant (Kt)	9.7	OZ - IN / A	+/- 10%
DC Armature Resistance at 1.5 Amps	1.10	OHMS	+/- 15%
Armature Temp	155	DEGR. C	MAX
Peak Torque (motor-only)	500	OZ - IN	N/A

Planetary Gearmotor Output Parameters	**Value**	**Units**	**Tolerance**
Planetary Gearbox Ratio	6.75:1	N/A	N/A
Gear Motor Rated Continuous Torque	16.8	LB-IN	MAX
Gear Motor Rated Peak Torque	71++	LB-IN	MAX
Gearbox Shaft Output Speed (@ F.L.)	207	RPM	N/A
Gearbox Standard Backlash	42	Arc - Minutes	MAX
Gearbox Efficiency	80%	N/A	N/A

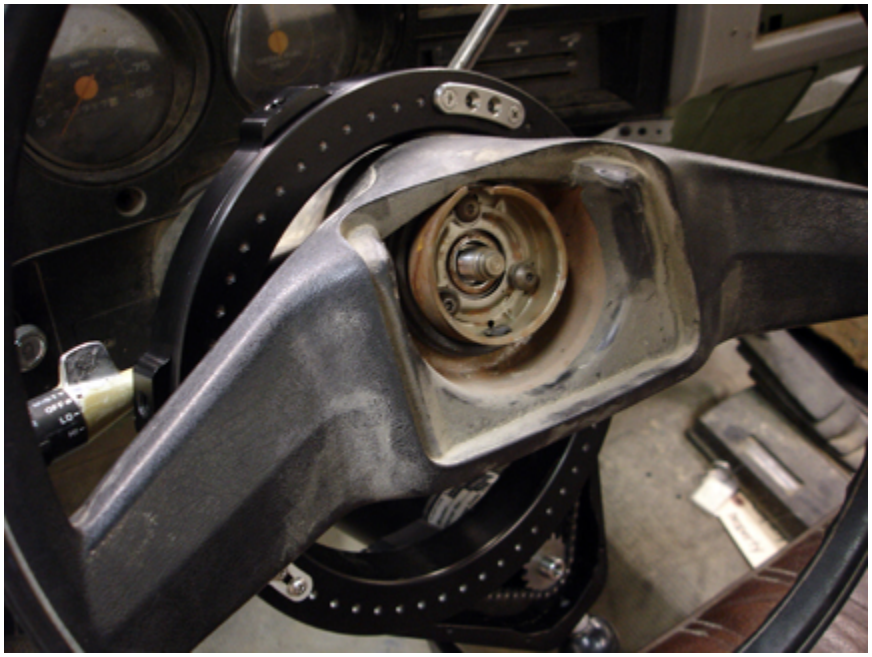
Table 2: 7:1 motor parameters

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Installing the Pronto4 Steering Ring

The simplest method of installing the steering wheel actuator is to remove the steering wheel.

- Before removing the steering wheel, center the steering wheel and make sure that the wheels are straight.
- Mark the steering wheel and column to assist in placing the steering wheel back on correctly.
- Once the steering wheel is removed, place the steering wheel actuator on the steering column and replace the steering wheel, aligning the marks made on the column and wheel.



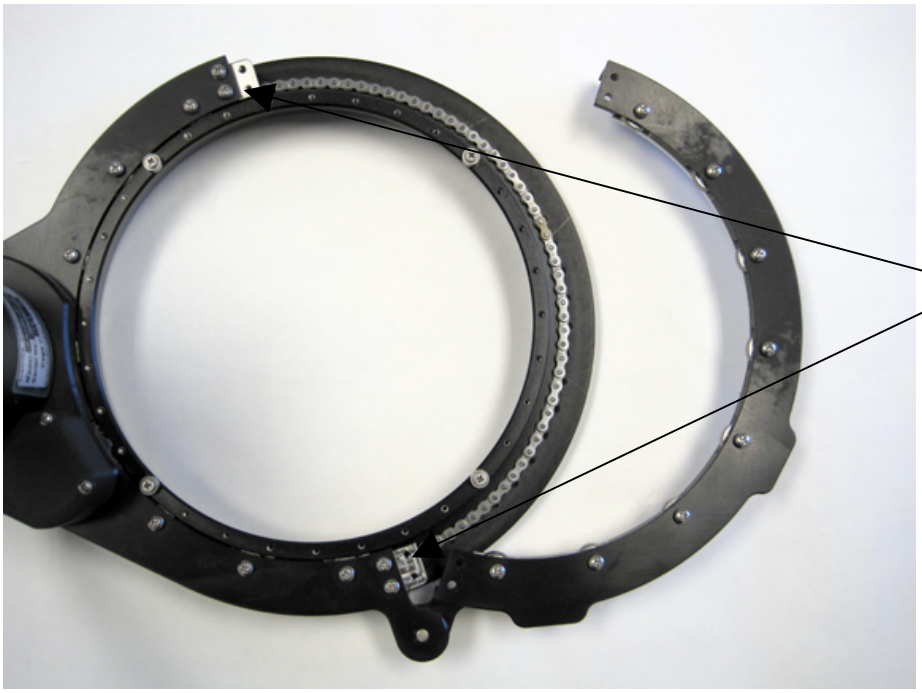
- Install the three steering wheel mounting brackets to the steering wheel actuator.
- Secure the steering wheel mounting brackets to the steering wheel.
- Please see below for connector overview and interface information.

The second method of installing the steering wheel actuator does not involve removing the steering wheel. The steering wheel actuator is designed such that it can be opened and placed around the steering wheel.

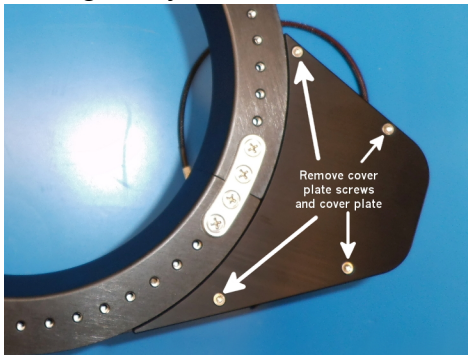
- Remove the four screws from the cover to expose the gear and chain.

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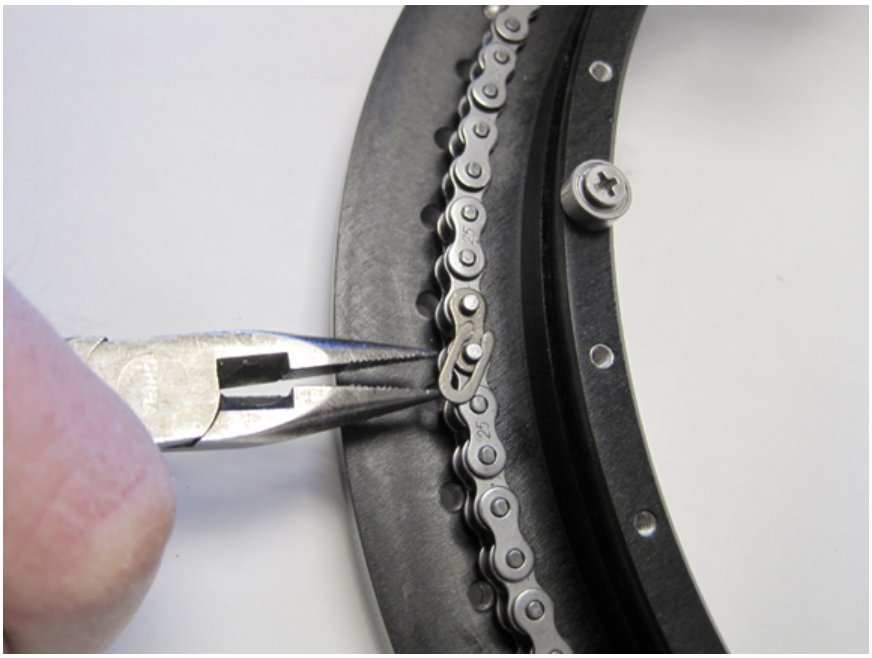
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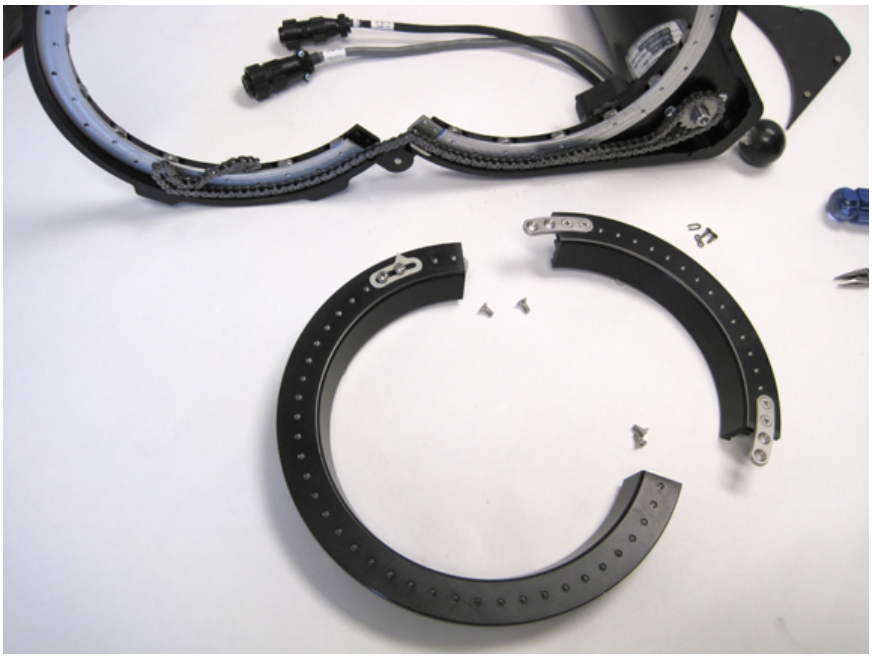
- There are four screws on the backside of the steering ring near the hinge. There is another group of four screws located on the backside on the opposite side.
- Remove two screws from each group that are attached to the same half of the steering ring. Part of the steering actuator should swing away.
- Remove the Motor Gear cover plate.
- Rotate the inner piece of the ring until the master link is visible. Remove the retaining clip and backing plate. Rotate the inner piece until the master link can be removed.



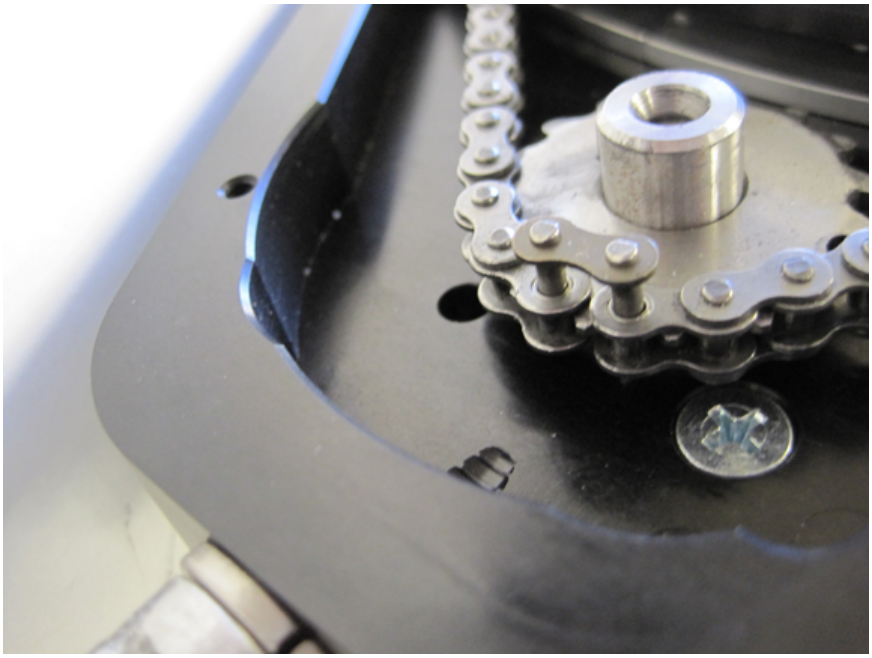




- Remove the chain. The inner section should come free allowing the steering actuator to fully open.



- Place the steering actuator around the steering column. Replace the inner section and chain.
- Remove any kinks in the chain and place both ends of the chain on the motor gear and replace the master link.



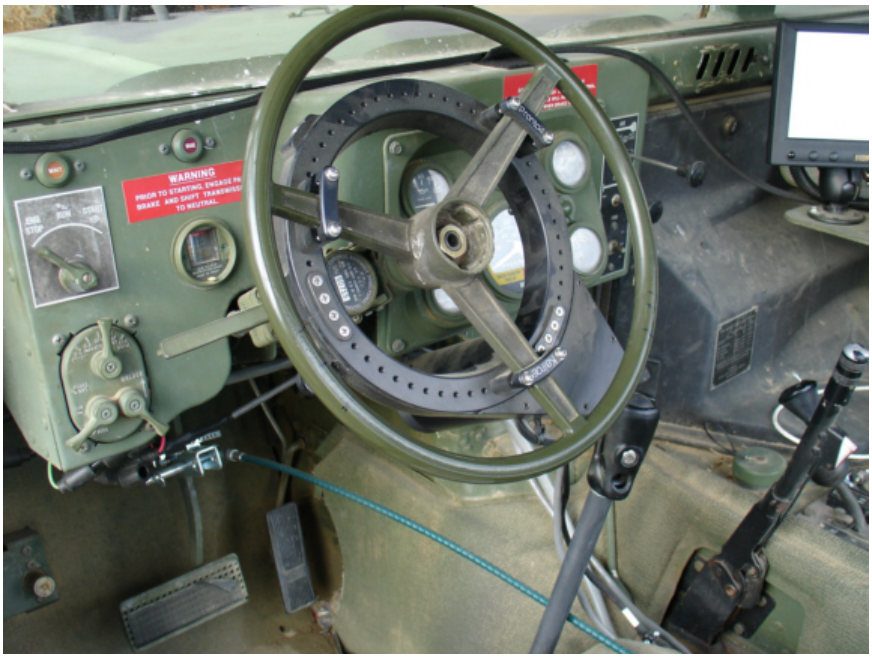
- Rotate the inner piece until the backing plate and retaining clip can be placed back on the master link.
- Close the outer portion of the steering wheel and reattach the four screws that were removed earlier.
- Replace Motor Gear cover plate.
- Install the three steering wheel mounting brackets to the steering wheel actuator. These brackets may need to be bent to fit your particular steering wheel.
- Secure the steering wheel mounting brackets to the steering wheel.
- To attach the bias pole, attach the ball mount with flange to the vehicle. This can mount to the floor or to the seat by means of an adapter. Place the bias pole on the flange ball mount and the other end to the ball on the steering actuator. Tighten down the arms.

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Reference Pictures



Steering Ring installed in a military HMMWV.



Steering Ring installed in a Kawasaki Mule.

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Steering Ring installed in a Ford Ranger.

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Tuning the Steering Ring

There are two versions of the Pronto4 steering system – one has differential encoder signals, and includes the limit pots on the encoder PCB, and the older version has standard encoder signals, and the limit pots are located on a small pendant.

Configuration for the original system (non-differential encoder, pots on pendant, 16-pin AMP connector):

1) Jumpers: On the limit board, L1 should be set to LCL, L2 should be set to CL, and JP1 should be loaded. JP2 and JP3 should not be loaded.

Instructions for tuning the original system (non-differential encoder, pots on pendant, 16-pin AMP connector):

1) Motor Direction: In ServoPod, disable the limits in the h-bridge tab, and command the wheel to move both left and right. Verify that the wheel moves in the correct direction. If not, swap the motor leads on the AMP connector.
2) Encoder Direction: Unplug the motor, and manually move the ring to the left. Verify that the encoder counts in ServoPod increase. If not, swap the encoder leads (2 and 3) on the 16-pin AMP connector.
3) Potentiometer Direction: Using a voltmeter, ensure that the voltage on the calibration pot increases when the steering ring is rotated to the left. If not, swap the VCC and GND leads (5 and 7) on the 16-pin AMP connector.
4) Re-enable the limits in the H-bridge tab of ServoPod.
5) Center Tuning: Using a voltmeter, place the geneva gear on the calibration pot in a position where the pot will not roll over if the geneva gear is turned 6 clicks in either direction. Center a notch on the geneva relative to the pot enclosure. Tune pot VR3 (on the small pendant, closest to the cable) until the center limit indicator in ServoPod goes on and off when the geneva is rotated around the center notch.
6) Rotate VR1 all the way CCW, and VR2 all the way CW.
7) Limit Tuning (CCW): Turn the ring 1.25 turns to the left, and rotate VR1 CW until the limit light goes on and off as the geneva gear is cycled around the notch.
8) Limit Tuning (CW): Turn the ring 1.25 turns to the left, and rotate VR2 CCW until the limit light goes on and off as the geneva gear is cycled around the notch.
9) Reconnect the motor and verify proper operation.

Configuration for the current system (differential encoder, pots on encoder, 9-pin AMP connector):

1) Jumpers: On the encoder board JP1 should be loaded, and JP2 and JP3 should not be loaded. The red motor lead should go to pin 4 of the amp connector, and the black lead to pin 1. Encoder connections are as follows: B1 to pin 6, B2 to 7, A1 to 8, A2 to 9.

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Instructions for tuning the current system (differential encoder, pots on encoder, 9-pin AMP connector):

1) Motor Direction: In ServoPod, disable the limits in the h-bridge tab, and command the wheel to move both left and right. Verify that the wheel moves in the correct direction. If not, swap the motor leads on the AMP connector.
2) Encoder Direction: Unplug the motor, and manually move the ring to the left. Verify that the encoder counts in ServoPod increase. If not, swap the encoder leads (6 through 9) on the 9-pin AMP connector. Pin 6 (A1) should exchange positions with pin 8 (B1), and Pin 7 (A2) should exchange positions with Pin 9 (B2).
3) Potentiometer Direction: Using a voltmeter, ensure that the voltage on the calibration pot increases when the steering ring is rotated to the left. If not, swap the VCC and GND leads (1 and 3) on the 3-pin molex connector on the limit/encoder board.
4) Re-enable the limits in the H-bridge tab of ServoPod.
5) Center Tuning: Using a voltmeter, place the geneva gear on the calibration pot in a position where the pot will not roll over if the geneva gear is turned 6 clicks in either direction. Center a notch on the geneva relative to the pot enclosure. Tune pot VR3 (on the small pendant, closest to the cable) until the center limit indicator in ServoPod goes on and off when the geneva is rotated around the center notch.
6) Rotate VR1 all the way CCW, and VR2 all the way CW.
7) Limit Tuning (CCW): Turn the ring 1.25 turns to the left, and rotate VR1 CW until the limit light goes on and off as the geneva gear is cycled around the notch.
8) Limit Tuning (CW): Turn the ring 1.25 turns to the left, and rotate VR2 CCW until the limit light goes on and off as the geneva gear is cycled around the notch.
9) Reconnect the motor and verify proper operation.

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Pronto4 Steering Actuator Interface: Steering Signals

Power: Steering Power Pinout

AMP 206429-1, Mate: AMP 206430-1, 206430-2

Pin	Function
1	Steer+
2	
3	
4	Steer-

Table 3: Steering Power Pinout

Apply +12V to Steer+ and 0V to Steer- to move the steering ring left. Apply +12V to Steer- and 0V to Steer+ to move the steering ring right.

	Steer + (Pin 1)	Steer – (Pin 4)
Left	+12V	0V
Right	0V	+12V

Table 4: Steering Power Signals

Position: Steering Signals Pinout

AMP 206708-1, Mate: AMP 206705-1, 206705-2

Pin	Function
1	Center Limit
2	Left Limit
3	Right Limit
4	+12V
5	GND
6	CHA1
7	CHA2
8	CHB1
9	CHB2

Table 5: Steering Signal Pinout

The Pronto4 steering actuator uses a differential quadrature encoder to indicate steering position. Channel A and B use +5V logic. When the steering wheel moves left then A leads B. When the steering wheel moves right then B leads A. Position can be determined by counting the pulses produced by the encoder.

Steering Motor	Counts per Rotation
7:1 Ratio	6045
14:1 Ratio	12090
16:1 Ratio	13817

Table 6: Counts per Full Rotation

Additionally there are signals that indicate full left rotation, full right rotation and rotation about the center position. When the steering ring has been moved to the right of center, then the center limit is high (+5V). When the steering ring has been moved to the left of center, then the center limit is low (0V). When the steering ring has been moved 450 degrees to the left then the left limit is low. When the steering ring has been moved 450 degrees to the right then the right limit is low.

	Position = -450	-450 > Position < 0	0 < Position < +450	Position = +450
Left	L	H	H	H
Right	H	H	H	L
Center	L	L	H	H

Table 7: Limit Levels

Connector Overview
Below is an overview of the connector part numbers and common function of each.

Steering Power
AMP 206430-1, Mate: AMP 206429-1

Pin	Function
1	Steer+
2	
3	
4	Steer-

Table 8: Steering Power Connector

Steering Signals

AMP 206705-1, Mate: AMP 206708-1

Pin	Function
1	Center Limit
2	Left Limit
3	Right Limit
4	+12V
5	GND
6	CHA1
7	CHA2
8	CHB1
9	CHB2

Table 9: Steering Signal Connector

Technical Support

Kairos Autonomi offers telephone support for hardware issues. We are available from 8 a.m. to 5 p.m., M-F, MST. Many days we are available outside of these hours (but that is not guaranteed). You can reach us at 801-255-2950.

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