

OPERATION MANUAL

- Operation
- Dockside checkout
- Sea trials
- Maintenance & Troubleshooting
- Specifications

MANUFACTURED AND SOLD DIRECT BY
CPT AUTOPILOT INC.

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OPERATION OF THE CPT AUTOPILOT

The CPT is an extra crew member to man the wheel, day or night, rain or shine. It is amazing to take your hands off the wheel and experience the freedom the CPT provides.

WARNING!

Always remember to maintain a proper look-out

Do not use the CPT in traffic or in waters where navigation is restricted!

An autopilot is NOT a substitute for good seamanship. Always maintain a permanent watch by the helm.

INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA, 1972 (72 COLREGS)

Part B - Steering and Sailing Rules

Section 1 - Conduct of Vessels in any Condition of Visibility

Rule 5 - Lookout

Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and risk of collision.

WARNING!

**KEEP CHILDREN AND PETS
AWAY FROM THE CPT BELT**

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CPT Operation

Turn power on with Rudder control. Wait at least 1 minute for pilot to warm up before using.

To Steer with Autopilot:

Hold boat on desired heading 30 seconds. Engage Clutch. Flip toggle-switch up to Hold Heading. Fine tune Rudder and Deadband as needed.

To Hand steer:

Flip toggle-switch down to Standby and Disengage Clutch

* In an emergency, the wheel can be forced to overpower the clutch and shear the shear-pins

Rudder: Controls autopilot Rudder Response
 Determines proportionally how far to turn wheel for heading corrections.
 High settings turn boat's rudder more; Low settings turn boat's rudder less
 Turn to 5 at start, then increase or decrease as needed. Set as high as possible without causing over-steering

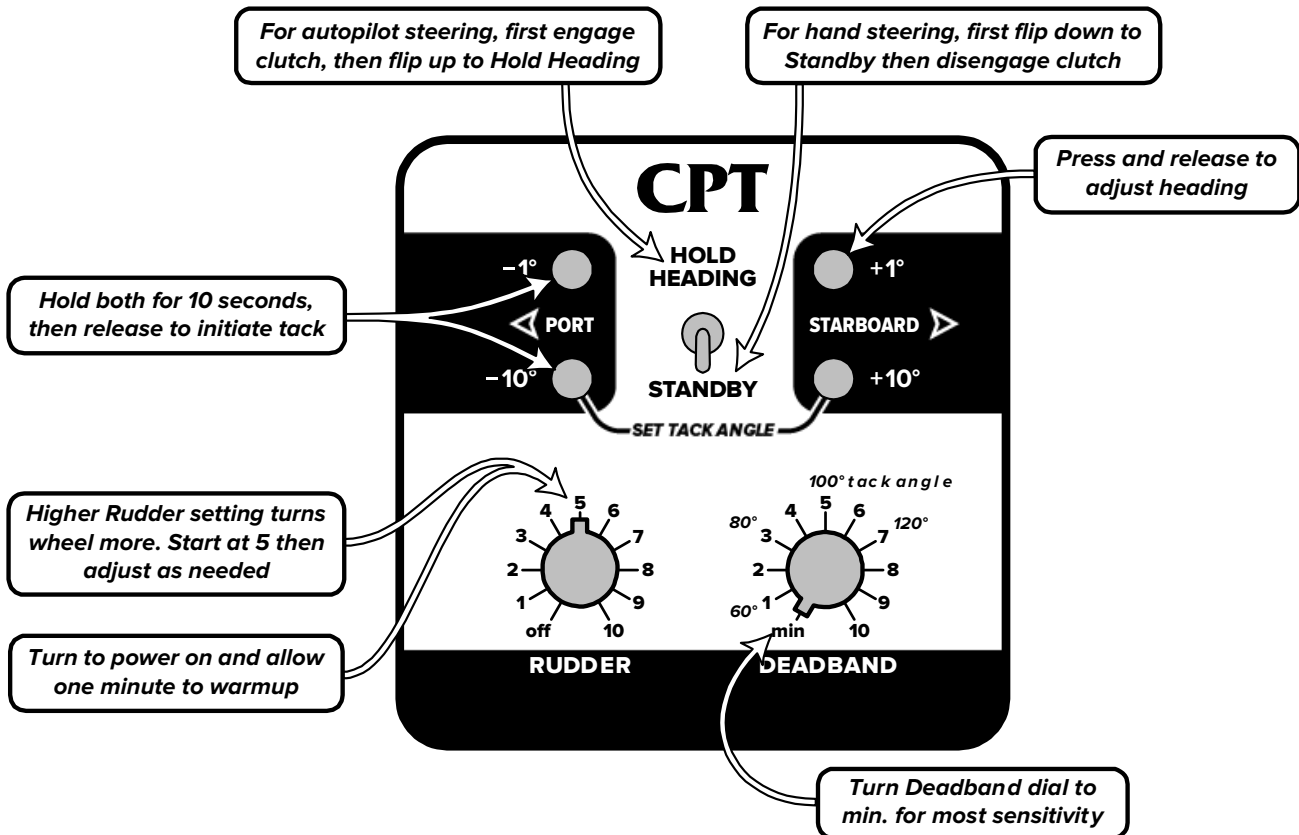
Deadband: Controls autopilot "Dead Range"
 Determines "sensitivity" to boat heading changes. Use to adjust for sea conditions.
 Low settings hold boat to a tighter heading Lowest setting allows approximately $\pm 1^\circ$ heading range
 High settings allow the boat to steer within a wider heading range Setting of "5" allows approximately $\pm 10^\circ$ heading range
 Turn to minimum at start. Increase only after rudder control is set and autopilot is steering adequately

1° and 10° buttons: Push and release buttons to adjust heading; changes target heading
 Check boat headway and rudder/deadband if boat is not responding (1° button will not be immediate)

Tacking: Simultaneously hold down the 1° and 10° buttons for the direction you wish to tack. Keep both buttons pressed for five seconds. Release buttons to tack. Set deadband low to keep the boat close to the new tack heading.
 * Flip to Standby and disengage clutch if stuck in irons or no wind to prevent wheel hitting rudder-stops

Change Tack Angle: Hold both 10° Port and 10° Starboard buttons down at the same time. Turn deadband dial to new tack angle and release buttons to set. Remember to return deadband dial to desired deadband setting afterwards.

* Tack angles are approximate and will vary from boat to boat based on the magnetic environment. You will have to see which angle works best for your boat.



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OVERVIEW OF AUTOPILOT OPERATION

The rudder control and deadband control must be set properly for the CPT to hold heading. Tack angles are approximate and will vary from boat to boat based on the magnetic environment and deadband setting, you will have to see which angle works best for your boat.

A. Setting Rudder and Deadband controls

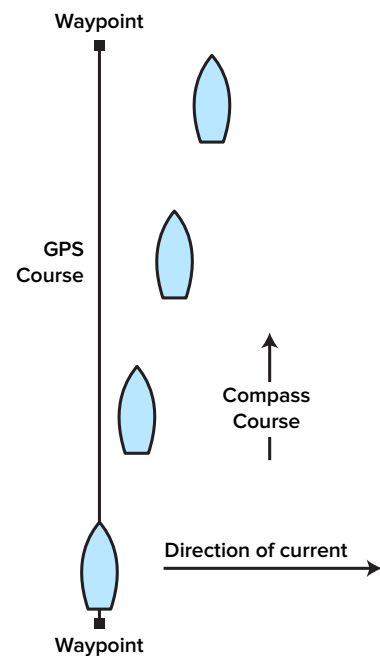
The Rudder dial should be set high enough so that when the boat falls off it is brought back to heading with just one or two “pulses” or wheel corrections. If the pilot makes repeated pulses or wheel corrections in one direction the rudder control is set too low; the setting needs to be raised. If the pilot oversteers, lower the setting a bit. High rudder settings provide larger rudder corrections, low rudder settings provide smaller rudder corrections. The boat must be balanced and respond to the rudder in a consistent manner, as the rudder dial sets the rudder response for one consistent response.

Start with the Deadband dial (dead range) set to minimum, especially when first using the pilot. If the pilot is making port and starboard corrections too frequently, or reacting to swell, gradually raise the deadband setting so that corrections are made when needed but are not constant. Low deadband settings provides more sensitivity to heading changes, high deadband settings provide less sensitivity when in swells and seas. A deadband of 5 allows the boat to range approximately $\pm 10^\circ$ to port or starboard.

The CPT's performance can be improved by careful tuning but continuously adjusting the controls is not necessary. Once you find the rudder and deadband settings that work best for your boat, you'll use the same settings most of the time.

B. Magnetic Headings

The CPT keeps a vessel pointing to a magnetic heading; this is not the same as a GPS course. In keeping to a compass heading, your vessel will point the same direction but still be subject to drift from wind and currents. This drift will be apparent when observing your GPS over time, and periodic heading adjustments will easily keep the vessel on your waypoint course.



AUTOPILOT CONTROLS

Autopilot Steering

1. Disengage clutch, flip toggle to Standby. Turn power on with Rudder control. Allow one minute to warmup.
2. Hold boat on heading for at least 30 seconds. Engage clutch. Flip toggle switch to Hold Heading.
3. Adjust Rudder and Deadband controls to suit conditions

Hand Steering

1. Flip toggle switch to Standby.
2. Relieve pressure from wheel and disengage clutch (grasp the black disk on clutch and pull outward $\frac{1}{4}$ ")

Hold Heading / Standby Toggle

After a 1 minute warm up, flipping the switch to Hold Heading sets the pilot to the boat's heading.

Hold the boat steady on desired heading about 30 seconds, engage clutch, then flip to Hold Heading. Keeping the boat on heading for a longer period before flipping to Hold Heading will allow the pilot to match your heading more closely.

When toggled to Standby, the pilot is on standby and the motor will not turn. The clutch can now be disengaged for hand steering.

During the warm-up period the sensor heading will drift. Allow at least 1 minute for the pilot to warm-up before flipping to Hold Heading, otherwise pilot will respond to drift and correct in one direction once/second when more than 5-degrees from boat's heading.

1° and 10° Buttons

The push-buttons allow you to alter the target heading in 1° and 10° increments. The target heading is altered when the button is released. Pressing and releasing once alters the target heading once, pressing and releasing twice alters the target heading twice, pressing and releasing three times alters the target heading three times, etc. The deadband setting will affect how close the boat stays to the target heading. Due to differences between boats, heading adjustments are not exact; check your ship's compass after settling on the new heading.

It is easy to lose track when pressing buttons multiple times, and you may overshoot the desired heading if the boat is slow to respond due to currents or conditions. In these cases flip to Standby and then back to Hold Heading when the desired heading is reached or flip to Standby and steer to the new heading manually.

A note about the 1° button response:

When you push the 1° button, the new target heading will change by one degree, but you **will not** see an immediate motor response until the boat strays out of the deadband range. The tightest course-holding is when the deadband is set to the lowest setting (min), which allows a “dead-range” of about two degrees. If the bow of the boat strays more than about one degree port or starboard the pilot will take corrective action with the 1° button; when the boat is within that range there will be no immediate motor response.

Tacking

Tack angles are approximate and will vary from boat to boat based on the magnetic environment and rudder response. You will have to see which angle works best for your boat. In general, point as high as you can while keeping good boat speed before tacking. Set deadband low to keep the boat close to the new tack heading.

Simultaneously hold down the 1° and 10° buttons for the direction you wish to tack. Keep both buttons pressed for five seconds. Release buttons to tack.

Port Tack: Simultaneously press Port 1° and 10° for five seconds and release.

Starboard Tack: Simultaneously press Starboard 1° and 10° for five seconds and release

The rudder control must be properly set and the boat must have adequate speed and rudder response for the tacking feature to work correctly. Keep an eye on boat response to avoid hitting the rudder stops; flip to Standby and hand steer if boat does not respond to the tack well or gets caught in irons. Making inadequate headway, pointing too high, or having unbalanced sails can cause the boat to lose speed and have poor response to the rudder—go to Standby and disengage the clutch to avoid hitting rudder-stops. If the boat is not tacking far enough, the tack angle can be increased; if tacking too far the tack angle can be decreased. Depending on the conditions and the boat's momentum, the boat may carry slightly past the tack before correcting to the final heading.

Adjusting the Tack Angle

The autopilot comes from the factory with the Tack Angle set to 100°. The deadband dial shows Tack Angle settings from 60°-120°. Turn the deadband dial to the desired tack angle. Hold the 10° Port and 10° Starboard buttons down simultaneously for two seconds then release them. Remember to return the deadband dial to desired deadband setting afterwards.

Rudder Control

The Rudder control turns the autopilot on, and determines how far the boat's wheel (and rudder) turns when a heading correction is needed; the response is the same for both port and starboard corrections and will not work well with play in the steering system. Low settings result in smaller wheel corrections, higher settings in larger wheel corrections. The corrections are proportional to the amount of heading change needed. **The best rudder setting will be high enough to return the vessel to heading with just one or two motor pulses or corrections.** If the pilot responds with many smaller repeated corrections in one direction, raise the rudder setting.

The rudder control performs like a helmsman in a fog who can only see the compass. If this helmsman is told to move the wheel exactly one inch for each five° heading error, he will do exactly that every time a correction is needed. If these motions result in under-control and sluggish corrections, you can tell him to move the wheel further for a given correction.

The boat must be balanced for consistent steering, it must respond to the rudder in a consistent manner; the rudder dial sets the rudder response for one consistent response. It will not adjust for sloppy or excessive play in a boat's steering system.

The rudder control is used to match the CPT's response to your boat's steering needs. Some boats take many turns of the wheel to move the rudder, while others take only a few. The rudder control can adjust for this. Every boat also responds somewhat differently to the rudder. Generally full keel boats with more turns lock-to-lock take a higher rudder setting, but this rule does not always follow for some spade-rudder boats.

If the rudder control is set too high for your boat, the wheel will turn too far; the boat will over-steer too far port and starboard. Lower the rudder setting.

The most common mistake seems to be setting the rudder setting too low. If the rudder control is set too low, the autopilot will make many small repeated corrections in one direction to return to the desired heading, and will spend a lot of time on one side of the rhumb line. The boat may gradually fall off and the pilot will not keep the boat on heading. Almost all boats require a rudder setting of 4 or higher.

Either of these actions is relatively easy to identify and, with some experimentation underway, you should be able to find the correct setting for your boat. A rudder setting that works while sailing in lighter winds may have to be raised when winds increase.

A boat may require a slightly higher rudder setting at low speeds than at higher speeds. A sailboat may require a higher setting when running than when beating and a higher setting when sailing than when motoring.

Full Keel Boats: A full keel boat with 3-4 turns lock-to-lock will typically use a rudder setting of 5-6.

Fin Keels and Spade Rudders: Response to the wheel may be more sensitive. The rudder setting will depend on the boat's response to the rudder, and you will need to see what setting works best. It may take more balancing and de-tuning for steady steering and keeping the boat from reacting to every gust or condition. With increased speed downwind, response to the rudder increases, and lowering the rudder setting slightly works well. If the boat is easily under-steered, over-steered, or has wheel play, the rudder setting may be a compromise between the two.

If you are becalmed, stuck in irons or not making headway, disengage the CPT. The CPT will continue to try and make heading corrections, but the vessel will not respond to rudder changes. If left unattended the rudder could eventually hit the rudder stops.

(Avoid hitting the rudder stops; if it occurs a looser belt provides some give and you will hear a warning thump as the belt jumps in its cogs; but if the belt is over-tensioned or used with a tensioner it eliminates any give in the system and the shear pins are designed to shear if the belt doesn't jump)

Deadband Control

The deadband dial determines how far the vessel can stray from heading before a correction is made (dead range). In a proportional pilot, there is always some deadband inside which the pilot does not activate. If this deadband is small, (1°-2°) the pilot will continuously run port or starboard making course corrections. In a seaway, a boat will yaw back and forth along the desired course as it makes its way over the waves, but generally it has enough directional stability to keep a fairly good average heading. An adjustable deadband permits the boat to work its way through the waves without continuously using the rudder to try to fight the natural weaving and movement of the hull.

The deadband setting is adjusted with the deadband dial. Start out with the deadband set to minimum when first using the CPT. Turning the dial clockwise increases the deadband. Most boats steer well at settings of 2-3 in swells, with lower settings in flat water. On long passages, turning the deadband and rudder up a bit higher can reduce battery use while still providing a good average course. A deadband of “5” will allow the boat to range about 10° to port or starboard of the target heading; the pilot will make a correction if the boat strays more than 10° to port or starboard. When the boat’s heading is within the deadband range, small heading adjustments made with the 1° button will change the target heading but not take immediate effect until the boat’s heading is outside the deadband range. The lowest deadband setting allows the boat to range about 1° to port or starboard of the target heading, depending on the boat’s response to the rudder.

Rhythmic CPT steering corrections, in time with the roll of the boat, indicate that the deadband may be too low. The deadband can be increased slightly to avoid constant correction. A low deadband does not always mean that the boat will maintain a straighter course; it can cause the pilot to over steer if the rudder setting is too high. In rougher seas, the deadband should be higher to avoid constant corrections. A lower deadband setting is generally beneficial when sailing downwind or in flat water. Lower deadband settings cause higher sensitivity to heading changes; higher deadband settings cause lower sensitivity to heading changes.

Most of the CPT's steering action should be periodic corrections. Raise the deadband a bit to avoid excessive battery drain and wear on the CPT.

Summary

The Rudder control determines how far the wheel should be turned when corrections are needed. The Deadband control determines when a correction is needed—sensitivity to heading changes and seas or “dead range”.

Setting the Magnetic Reference for Northern or Southern Hemisphere

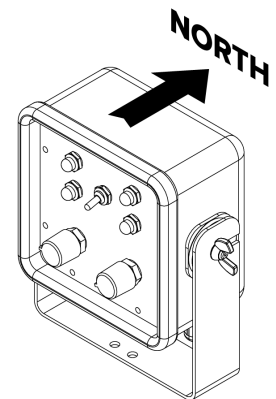
The autopilot comes from the factory set for the Northern Hemisphere’s magnetic field inclination. If you are located south of the equator or approaching the poles, the Magnetic Reference should be set again on location. Do not reset the magnetic reference as a routine trouble-shooting measure, as the magnetic field inclination will only start to become noticeable if you are located below 15-degrees South.

This procedure is best performed at the dock in flat water. If at sea, only perform this procedure in calm seas while holding the control box to stabilize it. If the control box is not kept level or is bumped during this procedure, the reference may be skewed resulting in poor autopilot performance.

Steps:

Turn the Rudder dial to OFF and remove the control box from its bracket.

Hold the control box so that it is pointed due North (the controls should face South.)



Hold the control box so the top is level and steady; you can hold it shoulder-height or rest it on a cockpit seat, but keep it away from metal objects and any possible magnetic fields. The center of the cockpit, about shoulder high is usually free from magnetic fields on most boats.

While holding the control box steady, simultaneously press and hold both the Port 1° and Starboard 1° buttons then turn the Rudder dial to ON. Continue holding the buttons. The light will blink red 5 times and then remain solid: you can then release the buttons.

The Magnetic Reference is now set in memory, and only needs to be set again if you approach the poles or change hemispheres.

Changing the Motor Rotation

The motor rotation is preset at the factory for your installation but can be easily changed and re-set from the control box.

Standard Rotation: Drive Pulley Facing Forward

Turn CPT OFF. While off, push and hold the Starboard 1° and 10° buttons and the Port 10° button; hold all three buttons down at the same time.

Turn the pilot on while holding the three buttons down.

Release the buttons after five seconds.

If successful, the LED on the control box will blink red eight times.

Reverse Rotation: Drive Pulley Facing Aft

Turn CPT OFF. While off, push and hold the Port 1° and 10° buttons and the Starboard 10° button; hold all three buttons down at the same time.

Turn the pilot on while holding the three buttons down.

Release the buttons after five seconds.

If successful, the LED on the control box will blink red eight times.

SAIL TRIM

Even the best autopilot can be crippled by poor boat trim, and the rudder and deadband settings effect how accurately the boat holds the heading.

The boat must be balanced on all points of sail and in all wind conditions for proper CPT operation.

This means that through the skipper's selection of sails, trim, and heading should tend to maintain a stable course without a significant amount of weather or lee helm. Reef and trim or head-off when wind and sea conditions increase. The CPT is not recommended for racing.

The rudder dial manually sets the rudder response for one consistent response, there is no automatic response for changing conditions.

When sailing, the boat should maintain adequate speed for effective rudder control; it must make enough headway for steering to be effective. When wind and seas increase, and especially when running downwind, quick rudder response becomes important; lowering the deadband and slightly raising the rudder control helps with full keels, and increasing vessel speed or falling off will lessen the effect of following seas. Fin keels may benefit from lowering the rudder setting due to increased speed and rudder efficiency. Always be aware of the relative wind angle, and keep the boat on a course to prevent an accidental gibe. If the boat is in danger of broaching, change heading or speed, reduce canvas, or put a competent helmsman at the wheel. Because of the manual rudder and deadband controls, the CPT performs best when the boat is balanced for consistent steering needs. If the wheel needs to be turned very little while going down the face of a swell, but then turned

wildly at the bottom or in gusts, the boat is not balanced for the conditions, and the pilot will not anticipate the constantly changing steering needs.

A. Boat Balance

A balanced boat has very little or no helm, either weather or lee. A boat that is in trim and balanced does not round up to windward at every gust. A boat with a heavy weather helm is one that has been poorly trimmed or is carrying a poor selection of sails. The boat should be trimmed for consistent steering needs.

By spending time trimming the boat properly before engaging the CPT, you will place lower current demands on your boat's electrical system, steer a straighter average course and create less wear-and-tear on both your boat and your CPT. Practically any boat can be made to sail with a balanced helm for reasonable lengths of time. You should strive for this as closely as possible before engaging the CPT.

B. Beating

Do not carry too much sail area and do not over-sheet the sails. This will create weather helm, excessive heel and probably slow you down. If the boat has weather helm, ease the main sheet until the main is on the point of luffing or just luffing slightly. If the boat still has significant weather helm, take in a reef on the main or slide the traveler car to weather, while easing the sheet to put some twist in the main to allow the top of the sail to luff. In heavy weather conditions where one sail will suffice, sail under jib alone.

In gusting conditions some boats, particularly fin keel/spade rudder boats and others with too much canvas spread, will head up at every gust. The main should be sheeted loosely enough so that it luffs as soon as the boat heads up. With some boats the main should be left luffing slightly when on course. This will allow the jib to push the boat off, as drive from the main is lost. Maintain a course that will give the boat an adequate steady speed and effective rudder control. The goal is to balance the boat, and eliminate the need to change the steering with every gust, to keep the steering needs consistent.

C. Running

If running downwind with twin poled-out jibs: The jibs should be sheeted a little looser than would be optimum so that if the boat tries to round up the leeward sail will spill air and the boat will return to course. If the main is carried, there should be a poled-out foresail on the opposite side. If conditions put the boat on the verge of broaching, the main should be dropped, or fall-off and change to a safer course. When it gets to surfing conditions, a competent helmsman should be in charge. Generally, at slow vessel speeds the rudder is less efficient and requires a higher rudder-control setting; higher speeds require a lower setting. Get to know your vessel's characteristics; there is usually an optimum vessel speed, course through seas, and amount of canvas that best balances the boat to meet the wind and sea conditions.

D. Reaching

Twin poled-out jibs or a main and a poled-out jib can be used up to 30° to 40° off a dead downwind course. (See the comments above on running.)

In high winds and particularly in gusting conditions, both sails must be sheeted looser than usual, or sail area reduced. **THE MAIN SHEET MUST BE EASED!** If the boat still wants to head up at every gust, put a twist in the main, reef it, or drop it.

Always rig a preventer to the boom when running or reaching in case of an accidental jibe.

APPENDIX

Dockside Checkout

The CPT is run for 24 hours at the factory before final testing, and the motor rotation direction has been preset for your type of installation. It should steer your boat easily and require not more than an hour or so of experimentation to become familiar with it. This dockside check should be performed after installation, before sea trials.

A. Checking the Steering System

Play in the system, any movement not immediately reflected by movement in the boat's rudder, should be eliminated or reduced to a minimum. All boats have some adjustment mechanism to take up slack and this should be used to eliminate play. At the same time, inspect the system for chafing, frayed cables, or binding. Grease as appropriate.

Hydraulic systems must be free of trapped air, use the proper fluid, and cannot have excessive wear or leakage past the piston seals. Air bubbles, foaming, or leakage must be corrected if the CPT is to operate correctly. Excessive valve delay in some systems may be inherent in the design.

B. Performing the Dockside Checkout

1. The belt should be installed on both pulleys
2. Disengage clutch and center the boat's rudder. (Pull out on drive pulley).
3. Flip toggle to STANDBY on Control Box.
4. Check that 10 amp fuse or circuit-breaker is in place in the red-wire 12 volt (+) line and power is available to the CPT.
5. For testing, turn the Rudder dial on and set to 5, turn Deadband dial to 1. Allow a minimum 60 second warm up period.
6. Engage clutch. Toggle to HOLD HEADING.

The pilot should not respond very much, and will make a small wheel correction after 20-30 seconds, then periodically every 10 seconds. If corrections are made every second either inadequate warm-up time was allowed or there is magnetic interference in the mounting location; do not attempt sea trial until corrected.

7. Push the 10° Port button once. The wheel should turn briefly to port, then stop, and will begin short pulse rotations to port once/second. Push the 10° Starboard button once, and the wheel should turn back to starboard and stop. Toggle the control box back to STANDBY. If the autopilot responds differently without a smooth return back to starboard, either inadequate warm-up time was allowed or there is magnetic interference in the mounting location.

*After a short time the pilot will eventually make a small periodic correction every 10 seconds, this is normal. Do not let the wheel turn until the rudder-stops are reached. Do not leave unattended. **To stop the wheel from turning: TOGGLE TO STANDBY AND DISENGAGE CLUTCH, or TURN PILOT OFF**

If the wheel is turning the wrong direction when you push the 10° button, you can reverse the wheel direction by following the directions for Changing the Motor Rotation on page 8.

If the wheel does not turn at all, check that the clutch is engaged, rudder at least 4, deadband at 1, and red power wire connected to +12V. If the power wires are connected wrong there will be no response from the controls and the pilot will not operate.

When left on Hold Heading, it is normal for the pilot to make a small correction every 10 seconds. More frequent corrections once/second usually means the pilot was not allowed adequate warm-up time, the boat's heading is changing slightly, or there is magnetic interference near the control box.

- Toggle to STANDBY. Turn the Rudder dial to off to turn off pilot. Disengage clutch by pulling outward on the clutch.

Warning: If left in HOLD-HEADING mode, the pilot will operate from boat movement at the dock: do not leave unattended, always flip to standby or turn autopilot off. Do not allow the wheel to rotate to its stops.

THIS COMPLETES THE DOCKSIDE CHECKOUT

Keeping Watch

The CPT is a helmsman who only sees the compass and not the surrounding sea and traffic. The skipper is responsible for keeping a good watch at all times.

DO NOT ATTEMPT TO USE THE CPT IN TRAFFIC OR IN WATERS WHERE NAVIGATION IS RESTRICTED! ALWAYS MAINTAIN A PERMANENT WATCH!

INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA, 1972 (72 COLREGS)

Part B - Steering and Sailing Rules

Section 1 - Conduct of Vessels in any Condition of Visibility

Rule 5 - Lookout

Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and risk of collision.

WARNING! KEEP SMALL CHILDREN AND PETS A WAY FROM THE CPT BELT!

Sea Trials

- Choose a day with light winds and calm water. Initial trials should be at a speed of three to five knots under power. After performing trials under power and becoming familiar with the unit, perform trials under sail, maintaining a balanced sail plan - no excessive weather or lee helm.
- Be sure there is plenty of room and no other traffic. The CPT should be off, clutch disengaged.

Flip the toggle to STANDBY, Rudder to 5, Deadband to lowest setting, allow 60 second warm-up.

Steer the boat on a steady heading for 30 seconds, engage the clutch, toggle to HOLD HEADING. (You may have to turn the wheel slightly to engage the clutch.)

The autopilot should make corrections to port and starboard to keep the boat on a straight heading. Do not use the 1-degree or 10-degree buttons during this initial test.

The rudder-dial must be set high enough so that only one or two pulses or wheel corrections are needed to keep the boat on heading. If over-steering occurs with a rudder dial of 5, slightly lower the setting, usually no lower than 4. If under-steering (3 or more small repeated wheel corrections), raise the rudder control.

Keep the deadband dial set low until you find the best rudder setting and only increase the deadband to reduce the pilot's sensitivity in seas; a low deadband setting provides high sensitivity to heading changes and heading adjustments from the 1° and 10° buttons.

- Rudder/Deadband:** These must be set properly for the pilot to steer. The **Rudder control** determines how much the rudder needs to turn to make a correction, the **Deadband control** determines how far the vessel can stray before a correction is made (dead range). Do not use the 1-degree or 10-degree buttons until rudder & Deadband are properly set.

* **Rudder control too low:** If the CPT makes **repeated small corrections** in one direction, raise the Rudder setting. The wheel will not turn enough to keep heading, and the boat may gradually fall-off. Increase the Rudder setting until the boat responds to both port and starboard heading changes **with only one or two corrections or pulses.**

* **Rudder control too high:** If the CPT steers too far to port and then too far to starboard, lower the Rudder setting. If the wheel turns too far when the CPT makes corrections, the boat will over-steer; lower Rudder just enough to prevent over steering. Set the rudder control as high as possible, but not so high that it over steers.

(If the boat falls too far off while adjusting the rudder setting, toggle to STANDBY, disengage the clutch and return the vessel on heading before trying again.)

* **Deadband control too low:** If the motor runs continuously back and forth, to port and then to starboard too frequently, or with each swell, **Raise the Deadband.** Gradually increase the deadband setting so that corrections are made when needed but not constantly. This will reduce motor operation and the vessel will still maintain a good average heading. Gradually lower the deadband setting if the CPT waits too long to make corrections.

Push the 10° PORT or STARBOARD button once. The boat should turn to the new heading and settle there. If it turns past the new heading, and then makes a series of corrections back, lower the rudder setting and try again. If it approaches the new heading with a major correction and then additional smaller corrections, increase the rudder setting. With a few trial turns you should find a setting to bring the boat steadily to the new heading without over-steering or delays.

4. For the CPT to steer, the boat must make adequate speed and headway. At very slow speed in the water, when pointing too high, in irons, drifting, or when the wind dies, the boat's rudder will be ineffective. The boat will not respond to any autopilot rudder corrections and the wheel will eventually hit the rudder stops. Disengage the CPT until you are making adequate headway.
5. The CPT will accept heading changes by pressing the 10° or 1° buttons. Push the 10° button two times for 20°, three times for 30°, etc. Due to differences between boats, heading adjustments are not exact; check your ship's compass after settling on the new heading. Make adjustments in increments until you are on the ship's compass heading you require. Rather than pressing buttons repeatedly and over-shooting your heading it is usually best to wait and allow the boat time to respond. The boat may be slow to respond due to wind, sail imbalance or sea conditions. You can also toggle to Standby and then back to Hold Heading to avoid over-shooting a heading, or simply go to Standby and hand steer to make major heading changes.
6. Tacking
Tack angles are approximate and will vary from boat to boat based on the magnetic environment and rudder response. You will have to see which angle works best for your boat. In general, point as high as you can while keeping good boat speed before tacking. Set deadband low to keep the boat close to the new tack heading.
 - Simultaneously hold down the 1° and 10° buttons for the direction you wish to tack. Keep both buttons pressed for five seconds.
 - Release buttons to tack.

The pilot will make the turn until the new heading is reached. Be sure boat is making the tack with adequate headway; disengage if the boat stalls or gets stuck in irons to avoid hitting rudder stops. Depending on the conditions and the boat's momentum, the boat may carry slightly past the tack before correcting to the final heading.

The autopilot comes from the factory with the Tack Angle set to 100°. To change, see "Adjusting the Tack Angle" on page 5.

THIS COMPLETES THE SEA TRIALS

Maintenance and Adjustments

General Maintenance and Storage

After use, rinse salt off; lightly spray with fresh water and lightly wipe the CPT down with a cloth and dry it. Do not use alcohol or solvents to clean the motor box or control box as they may remove the paint and graphics. Store the unit in a dry place when not in use, or protect it with a wheel/binnacle cover or other appropriate cover. When the boat is laid up, take the pilot home if possible. Do not store it in a damp locker during lay-up, or a location subject to flooding or damp conditions. When stored, store control box and motor boxes on their sides, with the control dials and clutch facing sideways, not facing up or down.

WARNING! Do not store the CPT in the bilge or any locker liable to flooding, leaking, or standing water.

Belt Tension

Sliding the motor unit down on its mounting bracket slots with your hands tensions the belt. Pull the belt snug by hand by putting downward pressure on the motor box and tightening the wing nut. Do not over-tension the belt; it causes clutch wear and makes the clutch difficult to operate and the shaft can be bent. Over-tensioning also removes any beneficial “give” in the drive system. If it doesn't slip it is tight enough. **An over-tightened belt or use of a belt-tensioner does not allow any give;** a less tensioned belt will give warning of heavy loads or striking the rudder-stops with a skip and thump to warn of heavy loads. The hose-clamps on the pedestal bracket will need to be tightened after the foam scratch pads compress. Pedestal installations using a reverse mounting plate may sometimes need the bracket directly fastened to the pedestal with screws if the hose-clamps slip under heavier loads.

Pulley and Clutch Maintenance

The drive pulley is held in one of two positions (engaged or disengaged) on its shaft by a detent (spring-loaded ball), which fits into one of two grooves on the shaft. All parts are made of Delrin, Nylon or stainless steel.

Most clutch wear is caused when hand-steering under high belt tension without lubrication. Lubricate the drive pulley and shaft periodically. Salt water may leave salt crystal build-up in the detent. The Delrin drive pulley should be removed from the drive-plate, cleaned and oiled or greased periodically—more often in severe or heavy use conditions.

If the autopilot will not be steering for awhile, remove the belt from the small pulley and hang it over the binnacle or wheel shaft. This will lessen wear and prolong the life of the clutch when hand steering.

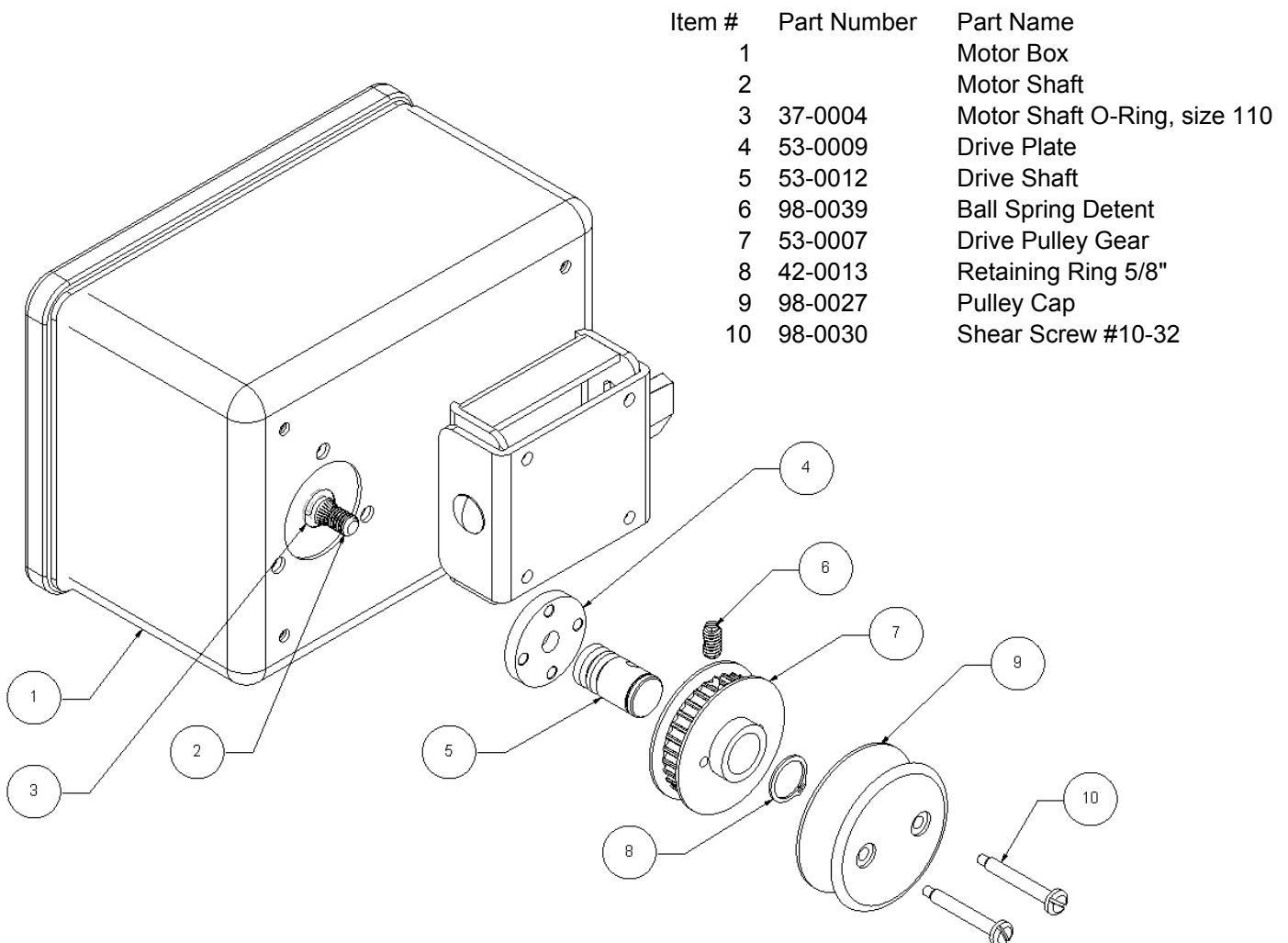
Each season service and lubricate the clutch/drive pulley. You should not remove the drive-plate unless the broken head of a shear-pin is stuck behind the drive-plate.

- Loosen tension on the drive belt and remove belt from the small pulley.
- Remove the two screws from the back of pulley cap; these are the shear-pins. (The black, grooved grip used to engage and disengage the clutch is the pulley cap. The screws are the machined shear pins.) **Do not attempt to remove the shear-pins if the pin ends are bent. Reach and straighten them with long-nosed pliers or a small vise grip first.**
- Remove pulley cap.
- Remove stainless steel retaining clip from its groove at the end of the shaft.
- Remove pulley gear.
- Rinse pulley in fresh water. Work the ball inside the shaft-hole in and out.
- Clean, dry and lubricate shaft. Work lubrication into the ball inside the shaft-hole.
- Replace pulley, retaining clip, and pulley cap.

- Replace the two shear screws. Do not over-tighten screws, they can strip or the pulley may distort. Rotate the pulley on the shaft and observe the ends of the shear screw pins.

Shear Pin Clearance Adjustment: There should be an even gap (1/16" approx.) between the end of the shear pins and stainless steel shaft-plate. If one of the pins is too close to shaft-plate, it may tend to catch in the plate holes when the wheel is turned. If the pulley does not turn freely, the pins are not even, or the pins are too close to the shaft-plate, back off one or both of the screws slightly. There is a slotted set-screw in the gear teeth to adjust the spring and ball detente.

The drive-plate⁽⁴⁾ does not need to be removed as part of normal maintenance. It may need to be removed if a broken shear screw⁽⁷⁾ head becomes trapped behind it. There is a hole in the shaft. To remove the drive plate, insert a narrow screw-driver and unscrew the stainless shaft from the motor shaft (it has normal threads). Gently pry the circular plate off the knurled motor shaft; gently pry all around the plate, force is not needed. Do not remove or lose the black-rubber watertight seal (O-ring) found under the plate. Clean the drive plate, shaft, and hub of the clutch gear. Oil or grease the parts before re-assembly. Be sure to work some oil into the detent ball that protrudes into the hub of the clutch gear. Replace belt and adjust the belt tension.



Connector Maintenance

Connectors for the power cable and control cable, if installed, should be maintained by applying silicone dielectric grease to both plug and socket contacts each season. Caps should be in place and tight if plugs are not fitted together. Connectors are a liability if not maintained and kept greased. The cable jacket should be kept sealed and not open or exposed. Corrosion inhibitor, Boeshield T-9 or similar lubricants should NOT be used on electrical contacts as they can leave an insulating film which inhibits electrical connections and is difficult to remove.

The CPT cables are not detachable from their boxes. The black cable fittings on control box and motor box are not plugs—do not loosen them. Attempting to remove them will void the warranty and may cause damage. The control box cable and power cable are soldered directly to circuit boards inside the boxes. After sea trials the control box cable may be cut and spliced for routing or connected to a terminal block below deck. The cable is color coded and shielded. Be sure the power wires are completely disconnected from the battery before cutting the control cable.

Wheel Pulley

After a season or two, check to make sure the wheel pulley is still centered on the steering wheel and adjust if needed. **Do not over-tighten J-bolts or the pulley will warp and distort over time. Tighten J-bolt until it makes contact and grips the spoke, then tighten the nut only another ¼ turn.** (See Installation Manual)

Factory Service

It is recommended that the CPT be returned to the factory to have the watertight seals replaced every 10 years depending on weather exposure and amount of use. This is also worthwhile if it has been used for many years and you are planning an extensive passage. There is a nominal charge, but if the seals become worn or brittle and salt water enters the unit, repairs may be extensive. The motor box and control box should be securely bubble-wrapped with ½" bubble-wrap, then separated by cardboard and boxed, and boxed again with 1" of peanuts when shipping.

Troubleshooting

Specialized equipment is required to service the CPT; there is no internal fuse or other internal parts that are owner-serviceable. For satisfactory and warranted repairs, repairs should be done only by the factory.

UNAUTHORIZED REPAIR ATTEMPTS VOID THE WARRANTY REGARDLESS OF CIRCUMSTANCE

Does Not Steer In Either Direction

Be sure shear pins are not damaged and that clutch is engaged.

Test that CPT has a good 12-volt power connection, with no oxidized connections. Check battery voltage (12 volts minimum), check voltage at power cable connection as pilot motor runs or would normally attempt to run (turn rudder to 10 and set to tack). A large voltage drop when the motor attempts to run indicates poor 12-volt connections and/or inadequate wire size. Trace power circuit back to the power supply for breakage, loose/oxidized connections, a blown fuse, defective fuse holder, etc. Poor connections, switches, and small gauge wires can cause voltage drop, blown fuses and damaged circuits. The pilot will compensate for voltage drop by drawing more current.

With the belt off and clutch engaged, turn the rudder control to 10 and tack to port or starboard; if you grip the small drive pulley with your hand you should feel good torque and not be able to stop the motor.

Motor: Engage the clutch after 1 minute warm-up, set rudder 5, deadband 1, toggle to hold-heading and press 10-degree button: CPT motor should rotate to make a heading correction. If there is no response, try back-driving the motor briefly by turning boat's wheel by hand; if this brings a response from the motor, it may be an indication of worn brushes or carbon build-up in the motor after seasonal storage. Back-driving the motor by hand may clear carbon build-up and restore brush contact.

Motor turns the wheel the Wrong Direction

The direction the motor rotates must be set for the wheel to turn the correct direction; it has been preset for your installation at the factory. See Changing the Changing the Motor Rotation on page 8.

Motor Runs But Drive Pulley Does Not Rotate

Check that shear screws are not broken or bent. The stainless drive-plate is fastened to the motor shaft by a setscrew. If the stainless drive-plate is loose, use a 1/8" hex key to remove Locking Set Screw. Tighten Cone Point Set Screw. Replace and tighten locking set screw. See diagram on page 14.

Motor will also turn very slow/weak if there is too much voltage drop in power wires.

Unit Will Steer/Turn in Only One Direction

Try turning the pilot off and restarting with the required 60 second warm-up.

Be sure there is no magnetic interference, and that the magnetic reference was set for your hemisphere; it is pre-set for the northern hemisphere at the factory, but can be changed as needed.

During the warm-up period the sensor heading will drift. Allow at least 1 minute for the pilot to warm-up after powering it on. Keep the vessel on a consistent heading for 30 seconds before flipping to Hold Heading. If the pilot is toggled to Hold Heading without adequate warm-up time, it may turn and pulse frequently (once per second) in the same direction. At the dock, while the boat is stationary and unable to respond, it is normal for the pilot to make a small correction every 10 seconds.

Continual turning one direction once per second while sailing or if the pilot steers on some headings but not others may be an indication of magnetic interference near the control box or failure to set the magnetic reference for your hemisphere. Refer to the section "Setting the Magnetic Reference" on page 7.

Under Steers, Boat Does Not Reach Heading Or Does So Slowly, Eventually Falling Off-Heading

Small repeated heading corrections in one directions indicates the Rudder control is too low - increase setting; turn rudder high as possible without causing over-steering. It may also indicate the Deadband is set too high—lower deadband setting (may be both conditions). Make sure boat is making adequate headway, set Deadband to lowest setting, Rudder high enough so that one motor-pulse brings the boat back to the rumblines.

Some spade rudders on racing-type hulls are easily understeered or oversteered, and the best rudder setting may be a compromise between the two.

Over steers, Passes Course, "S" Turns

Rudder control set too high – use lower setting. Deadband may be too low – increase the setting (may be both).

Rhythmic Steering, Corrects as Boat Rolls with Swells

Deadband set too low – increase setting.

Frequent Corrections to Port/Starboard, Rudder and Deadband Controls Ineffective: Wheel Play

This is typically from too much play in the steering system, or air bubbles, foaming or valve delay in hydraulic systems. The boat's rudder will not center, and play will alternate between port and starboard sides. The pilot tends to only hold heading within 10-20 degrees or more, understeering on one side, oversteering on the other, and the best rudder dial setting will be a compromise between the oversteering and understeering. Adjusting the rudder and deadband dials may seem to have little effect. To check for play in the steering system:

While having someone holding and locking the rudder quadrant to one side, measure how far the wheel turns. Place 18" of masking tape on the outside perimeter of the wheel, centered at the top of the wheel, top-dead-center (TDC).

Slowly rotate wheel starboard until it will not turn further: mark the tape TDC.

Slowly rotate wheel port until it will not turn further: make a mark on the tape TDC.

Measure the distance between the two lines: ____" Circumference of Wheel : ____"

Divide the circumference of your wheel by 360; the answer is the distance for one degree of wheel play for your wheel. Poor performance may occur if wheel play is more than 25 degrees. Wheel play in hydraulic systems can be harder to measure and may only occur under heavier loads or intermittently depending on the cause.

Belt Slips, belt adjustment, Excess Torque

The belt should be snug, but over-tensioning is not needed and will make the clutch hard to operate. If the belt jumps in the cogs under load, loosen the wing nut tension the belt by pushing down on the motor box and tightening the wing nut. The wing-nut is easier to tighten if you keep a little lubrication on the threads. The boat must be balanced to lessen weather-helm and provide consistent steering (See "Sail Trim"). Check the steering system for binding, bad control cable leads, damage, or lack of lubrication. Correct as necessary. Make sure wheel pulley is centered on wheel, and that belt is aligned. Make sure hose-clamps and bracket are tight and have not slipped on pedestal. For pedestal diameters less than 4", heavy wheel loads, or reversed pedestal installations: the pedestal bracket should be directly fastened to the pedestal with fasteners in addition to hose-clamps. If heavy loads cause the motor to flex the mounting so the belt slips, a belt tensioner will keep the belt tensioned and absorb shock loads from large rudders.

Clutch Disengages

Motor unit may be tilted so the drive pulley shaft is not parallel to the wheel shaft, and belt tension is disengaging the clutch. Pulleys must be aligned and parallel when the clutch is engaged. If in doubt or the wheel is not uniform favor a slight belt slant that will help keep the clutch engaged.

The set-screw recessed into the drive pulley-gear adjusts the friction of the ball bearing detente in the clutch. Slightly tightening this screw will lock the clutch more securely in position; tightening too much will make the clutch difficult to disengage. This normally does not need adjustment unless it has worked loose or there has been extensive wear. Use a small bit of thread locker if the screw has worked loose.

Shear Pin Breakage

Be sure all excess friction is removed from the steering system. Steering linkage with excessive play can transfer sudden shock loads from the rudder directly to the shear pins. Be sure the wheel pulley is basically centered on the steering wheel. Vessels with excessive rudder shock loads will benefit from use of a belt tensioner which acts as a shock-absorber.

If the tip of a broken shear pin is not removed, it may get lodged behind the drive-plate and cause a screeching sound behind the clutch. Remove the clutch & drive-plate to remove the broken tip.

A worn clutch pulley with excessive hub wear will no longer rotate on center and be wobbly, transferring belt tension to the shear pins instead of the hub and shortening shear pin life; contact us for a replacement pulley gear. To prolong the life of the clutch and shear pins when hand steering, loosen tension or remove the belt from the small pulley, and hang the belt on over the binnacle or wheel shaft. Clean and lubricate clutch on a regular basis.

CPT Steers +/- 10 degrees or more in seas, worse in flat water

Be sure the Deadband is set to the lowest setting. Otherwise this is usually an indication of excess play in the boat's steering system or some magnetic interference. Excess play at the wheel must be removed. Inspect and tighten cable systems. Air, foaming and valve delay in hydraulic steering systems must be removed. Try relocating the control box away from stereo speakers and any metallic equipment that may have a magnetic field; only 316 stainless fasteners should be used to mount the control box.

Poor Power Connections and Voltage Drop

Just checking for 12v at the line is not adequate; voltage drop will only show while pilot motor runs and draws current. The small drive pulley may barely turn or vibrate with excessive voltage drop in power line. With the

belt removed you should not be able to stop the small drive pulley with your hand. Also, if 12V power is interrupted, the CPT will not hold a heading during the 60 second warm-up. Loose power connections can cause the unit to intermittently turn off and power-up again, initiating recurring warm-up and heading loss.

HF Radios, Iron Objects, Magnetic Interference

Winch handles, screw drivers, knives, cell phones, ship's compass and other objects with steel/iron parts can alter the sensor heading if placed too close to the control box. Ham radios and SSB radios should be properly choked and grounded, and be used at 50% transmit power to limit effects and stress on all electronics onboard. Generally, SSB transmissions will not immediately affect the CPT, but long transmission times may gradually affect the heading, and also cause a noticeable magnetic field on the ship's compass. If SSB interference can't be lessened, it is recommended that the CPT remain off or on Standby mode during SSB transmissions.

Magnetic interference may lengthen the warm-up time for the sensor, lengthen the time taken to settle on a new heading, or if strong enough, completely prevent it from settling on a heading.

With steel vessels, the control box must be at least 6 feet from steel. With mild magnetic interference, the pilot may operate fine on some headings but not others, depending on the control box mounting location. A few older steering systems in fiberglass or wood boats may have magnetized parts in the pedestal, worm-drive or parts of the steering system or engine controls. Refer to the section "How to check for magnetic interference" in the CPT Installation Manual for more information.

Basic Circuit Function Test

To check basic circuit function, remove belt and engage clutch. Keep the vessel on a consistent heading during this test or at the dock. Flip control box to Standby, set Rudder to 5 and Deadband to 1. After a minimum 60 second warm-up, toggle to Hold-heading. The small drive pulley should be stationary for a brief time, and will begin to make a small correction every 10 seconds. Push the 10° port button once and the clutch should turn to port and then make momentary corrections to port. Push the 10° starboard button once and the clutch should rotate back to starboard and stop. Slightly rotating the control box itself should bring the same results. When left on Hold Heading when the boat is stationary, it is normal for the pilot to make a small correction periodically once every 10 seconds; making corrections once every second after 60-second warm-up indicates a magnetic field too close to the control box.

Reversed Power Wire

The CPT will not operate at all if the polarity of the power wires are reversed. The red wire must connect to +12V, the black wire to -12V.

Splicing Cable to Control Box

The control cable is a shielded cable with six 24ga color-coded wires. Damage resulting from cross-connecting wires during splicing or routing is not covered under the warranty. **Be sure the power wires are completely disconnected from the battery or 12 volt source before cutting the control cable or damage will result.**

TECHNICAL SPECIFICATIONS

Compass Sensor

Electronic heading sensor built into control box

Power Requirements

12 Volts DC

0.08 amp standby current

0.4 amp average current drain, varies with load and settings

Torque/rpm at Wheel

86 ft-lbs (116 Nm) – 12" Wheel Pulley

Up to 7rpm at the wheel

Dimensions

Motor Box

7" wide x 5" high x 3.5" deep

Control Box

2.5" deep, 4" high, 4" wide,

Wheel Pulley

12 5/8" OD, 10-3/16" ID, 1" thick

Weight

10 lbs

Materials

Motor box and Control box Units

Powder coated aluminum w/ anodized face plates

Delrin drive gear on 316 stainless shaft.

Wheel Pulley

Black Urethane

316 Stainless fasteners

Drive Belt

Fiberglass reinforced neoprene

Truly-Water Resistant

The control box and motor box are designed and built to withstand immersion. We prefer to call the CPT truly water resistant, as the term "waterproof" is often misunderstood. Storing the unit improperly in standing water or flooded conditions can eventually exceed the rating of the watertight seals.

LIMITED WARRANTY

The CPT is warranted for one year for defective parts and workmanship, provided the unit is installed and used in accordance with these instructions and common sense, as explained in the attached limited warranty card. You are cautioned to keep children, pets and fingers away from the belt, that the CPT cannot see or hear danger, it must be supervised to insure a safe course, and seamanship and watchfulness are required. A warranty card describing the limited one year warranty is included with each new unit. Please contact us if this card was not included with your unit. The warranty set forth in the express limited warranty is the exclusive warranty of the product and is in lieu of any other warranty whether implied or statutory (including warranties of merchantability and fitness for a particular purpose). The remedies available to the buyer are limited to the remedies described in the express limited warranty card.