

A large, faint background graphic consisting of a light blue gear with eight teeth, and a stylized orange and white fish or swimmer shape overlapping the gear.

TR-1 Gold **Owner's Manual**

Thank You

Your purchase of this **TR-1 Gold** outboard management system enters you in the prestigious fraternity of anglers who count on TR-1 to control their outboard kickers.

TR-1 Autopilots is dedicated to creating the finest controls and guidance systems for the best in boating and fishing.

TR-1 Gold represents that effort. Enjoy your best fishing partner ever. We're sure you will agree it is worth its weight in **GOLD**.

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Safety

You are responsible for the safe and prudent operation of your vessel. Your TR-1 Gold Autopilot is a tool that will enhance your capability to operate your boat and catch fish. It does not relieve you from the responsibility for safe operation of your vessel. You must avoid hazards to navigation and never leave the helm unattended.

You must always be prepared to promptly regain manual control of your kicker. The autopilot and the throttle actuators can fail hard over. Learn to operate your autopilot on calm and hazard free open water.

In case the autopilot becomes inoperable, remove the in line fuse from the battery power cable.

The steering cylinder can be removed from its mounting bracket on the outboard in case of hydraulic jamming.

Removing the actuating link between the stepper motor and the carburetor butterfly crank can disable the electric throttle.

Caution:

Before drilling holes in your boat, be sure you know what you are drilling into. Watch out for fuel tanks, electrical cables, and hydraulic hoses.

Do not run your pilot with the outboard hard on the steering stops for any extended time or you will burn out the pump motor.

Be sure to leave the system in Standby mode when Autopilot is not in use, or if the kicker motor is not running.

We recommend you use only BioSOY hydraulic fluid in your autopilot hydraulics.

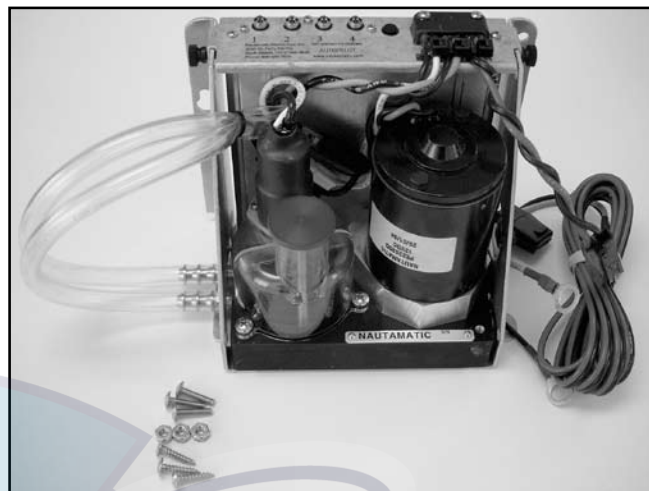
Keep your hands out of the outboard steering hinge area, the autopilot may steer the motor and smash (or worse) your fingers.

TR-1 Gold Autopilot System Parts List

Electro-Hydraulic unit.....
120-2100-00

Kinked tubing with tie wrap.....

3 ea. Truss head machine screws #8-32x 3/4
3 ea. Lock washer nuts #8-32.....
3 ea. Truss head sheet metal screws #8 x 3/4



Sensor Ball Unit.....
120-2200-00

Sensor Ball Bracket

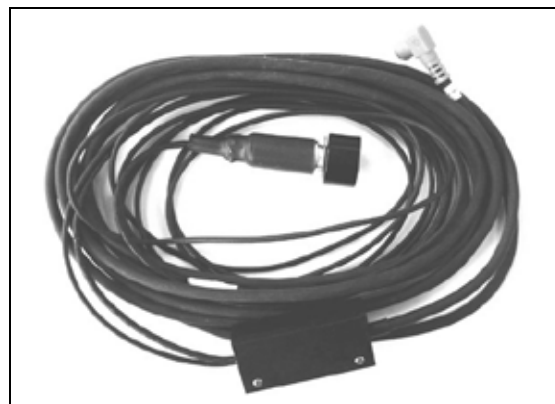
3 ea. Pan head machine screws #8-32 x 1".....
3 ea. Lock washer nuts #8-32.....
3 ea. Pan head sheet metal screws #8 x 1".....

Sensor Ball Capture Cage.....



Deck Mount Switch/Tach

120-2215-00



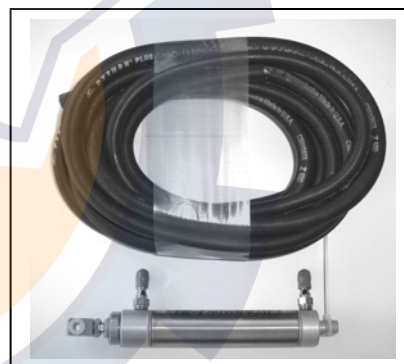
Handheld/Remote Unit.....
120-2020-00



Cylinder Mounting Kit.....
(Motor Specific)



18 feet Hydraulic Hose.....
120-0013-01



Steering Cylinder.....
120-0900-00



Throttle Actuator (Motor Specific).....

1 pt. Hydraulic Fluid
120-0001-01(Bio-Soy).....



TR-1 Gold Specifications

E-H unit	6.5"H x 7" W x 5" D	8 lb
Sensor Ball	3.6" Dia.	Cable length 18' 2 lb
Remote	5"x 2.5"x 1"	Cable length 18' 1 lb
Deckmount/Tach	5/8"x 2"	Cable length 6'
Battery Cable		Cable length 9'
Fluid	1 pt.	BioSOY Oil 1 lb
Supply Voltage	11.5 – 14.0	VDC
Maximum Current	12	Amperes
Inline Fuse		ATO 20 Amp
Operating Ambient Temperature		20 – 120 deg F

Introduction

This manual comprises two major sections. The first section is a guide to installation of the “onboard” components of the autopilot system on your boat. The second section is a guide to adjusting and operating your system. Installation instructions for the throttle actuator and steering cylinder are motor specific and are provided in separate manuals.

Preparation

You will be hard mounting three autopilot components in your boat: 1) The Electrohydraulic Unit. 2) The Deckmount switch. 3) The Sensor ball. These components are shown in relation to each other and to the engine mounted components in the *System Layout* diagram on page 8. As indicated by this diagram, the Electrohydraulic unit and the Deckmount switch are to be located near the kicker and the Sensor ball is to be located **FORWARD OF THE CENTER OF YOUR BOAT**

Spend some time to figure out where you are going to mount all of the components before you mount any of them. Place the components where you expect to mount them and verify you have access to and routes for the cables and hoses that connect the components.

• Mounting Screws

Mounting screws are provided for through and blind hole applications. You may choose to drill and tap the mounting surface.

SCREW	TAP DRILL	TAP	CLEARANCE	PILOT
#8 – 32 machine	#29 .136 dia	#8 –32		
#8 – 32 machine			3/16	
#8 sheet metal				1/8

- Access

The Electrohydraulic Unit is the place where all the components connect together and the place where fluid is added and fluid level is checked. Leave room for service loops in the cables and hoses.

The Deckmount switch should be easy to reach with your free hand when your other hand is on the kicker tiller. This can be done after the initial turn on blinking setup is complete. In case of an emergency, quick access to the deckmount switch is a good idea, by pressing the button once it will take the autopilot to standby, allowing you to take control of the tiller handle. Pressing the button again will return it to autopilot mode.

If you intend to hook up to GPS, the connection between the GPS and the autopilot is made at the Sensor ball and the NMEA 0183 output on your GPS.

- Protection

Locate the Electrohydraulic unit and Sensor ball in places where they will not get submerged or exposed to wash down.

Use a quality electrical insulating grease compound on all electrical connections (Dow Corning #4) except the orange connectors # 1,2,3, & 4.

- Moving Parts

Hoses and cables that connect the Electrohydraulic unit to the engine mounted components need to be free from binding and kinking. Be sure to remember your kicker moves up and down on the lift bracket, tilts up and down, and steers lock to lock.

- Hose Length

Try to keep the hose length between the steering cylinder and the Electrohydraulic unit short. But leave enough length for movement of Kicker (See note above on moving Parts).

- Magnetic Environment

The Sensor ball has a compass in it. **Do not mount the ball near magnetic materials**, magnets (speakers and electric motors), or high current carrying wires. Small, vehicle fixed, magnetic disturbances can be calibrated out, but moveable or changing magnetic disturbances such as anchors, anchor chain, and wiper motors should be kept at least 24" away. A common problem is to have mounted the ball near a glove box, and then someone puts tools in the glove box. Keep the Sensor ball away from Air Ride seats.

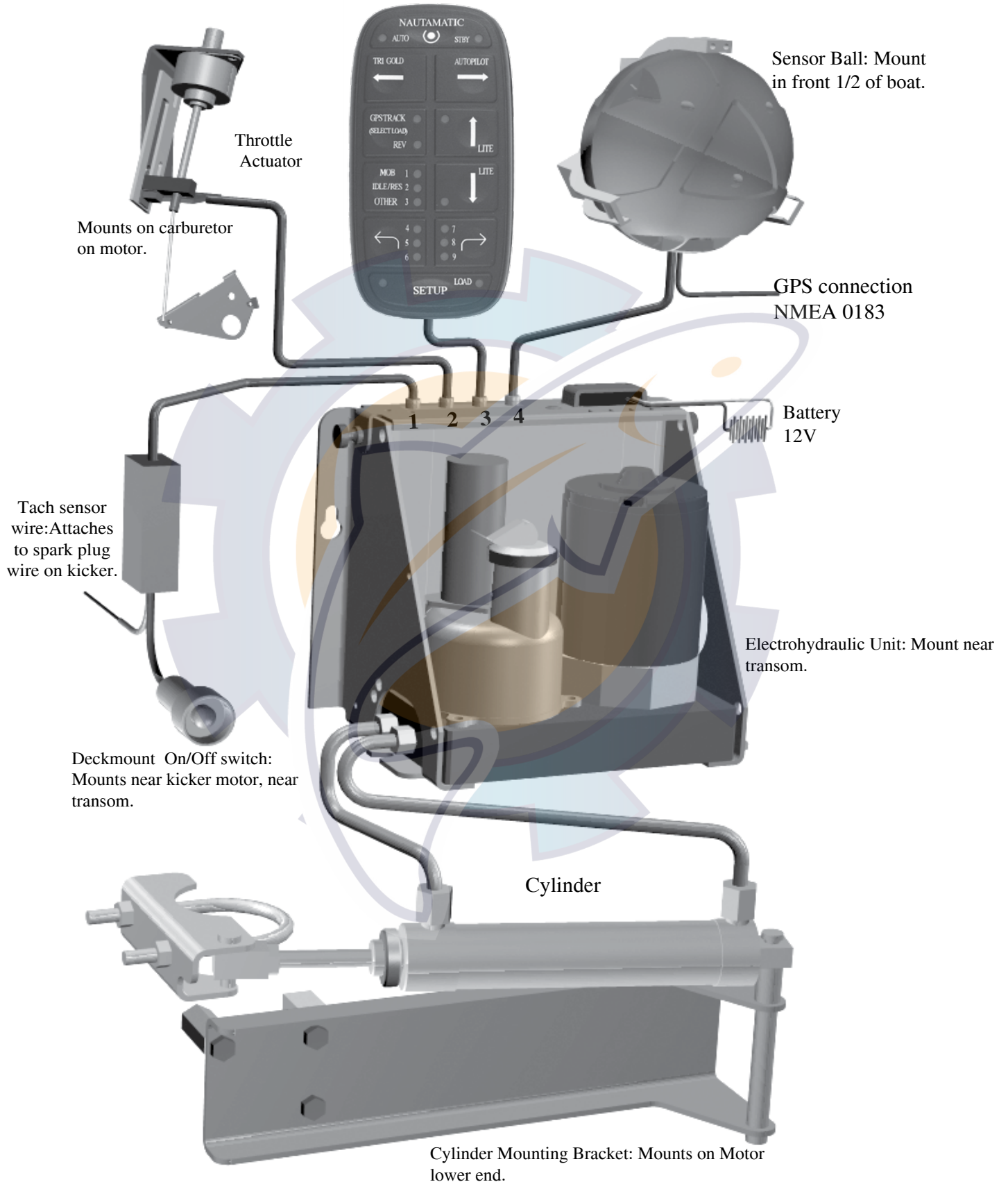
- Strain Relief and Cable Protection

Do not let the connectors on the Electrohydraulic unit be the sole support for the cables connected to them. Use the tie wraps to tie the cables down to the Electrohydraulic frame. There are several holes in the sheet metal frame provided for this purpose.

Don't run cables and hoses over sharp edges. Use grommets in through holes to protect the cables.

System Layout

Handheld/Remote



Tools

You should gather the following tools before beginning installation. See throttle and cylinder supplements for any additional tools that may be needed for your application.

Tools

Power Drill
 #1 Phillips screw driver
 .125 (1/8) or 3.17 mm dia. drill
 .469 (15/32) or 11.90 mm dia. drill
 Roll of masking tape
 Rags
 Knife
 Pliers
 Silicone RTV
 Loctite or similar product
 Electrical grease compound
 (Dow Corning #4)



Fig. 4

Installation of The Electro-Hydraulic Unit

Please read the complete instructions thoroughly before starting your installation. If you have any questions call our Tech Support line. 1-800-588-7655

Locate the Electro-Hydraulic unit where it it will not be subjected to water submersion or spray from wash down.

Step one (Template)

Find the mounting template in your autopilot documentation package. Use the wall or floor section of the template as needed. Decide which screw type you need. Hold the template in the place with tape and drill right through it in the three indicated locations. See *fig. 5*. Remove template and install screws in the indicated locations on template. Tighten these 2 screws down to 3/32" from the surface to allow enough space for the bracket on the pump to slide behind the screw.

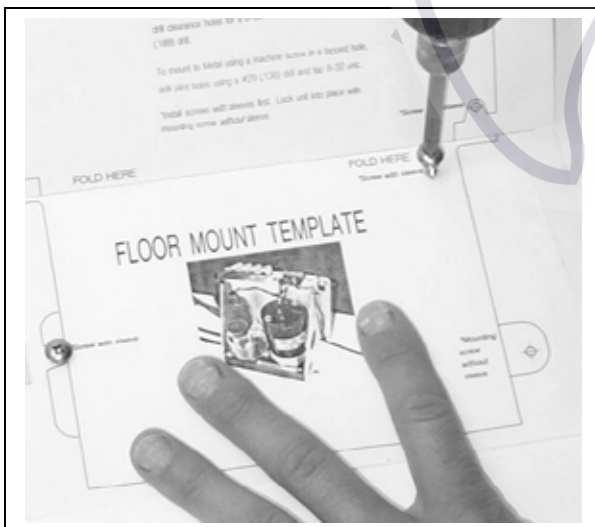


Fig. 5

Mounting Hydraulic Unit



Fig. 6

Step Two (Locking unit in place)

Floor Mount: Set the unit on the floor in front of screws. Slide the left side back and engage the notch between the hose fittings around the left hand screw. Pivot the unit on the left hand screw counter clockwise until the notch under the electronics box on the right hand side is engaged and the remaining hole you drilled lines up with the hole in the bottom tab of the right hand bracket. When the holes line up, put the last screw in and the E-H unit is locked in place, as shown in *fig.6*.

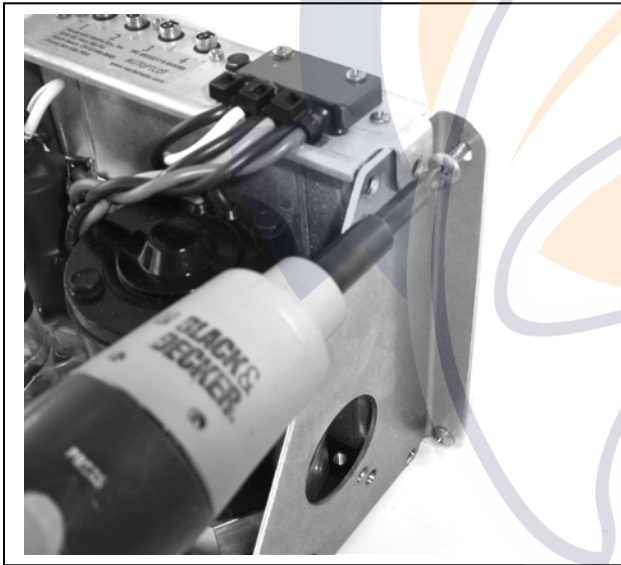


Fig. 7

Wall Mount: Set in place by hanging the unit on the screws. One is the keyhole shape on the upper left backside of E-H unit; the other is the notched area on the lower right side of E-H unit. Lock E-H unit in place by lining up the last hole on upper right hand corner.

Please note: You will need to remove the black plastic thumbscrew to place the last screw, as shown in *fig.7*

You may run the red and black wires to the battery box now, but **do not** connect to the battery yet.

Installation of the Sensor Ball

The Sensor (Compass) Ball needs to be mounted forward of the center of your boat. Make sure you mount it away from magnetic disturbances (stereo speakers, wiper motors, anchors). You will need to calibrate your compass on the water after installation of system and before you use the autopilot.

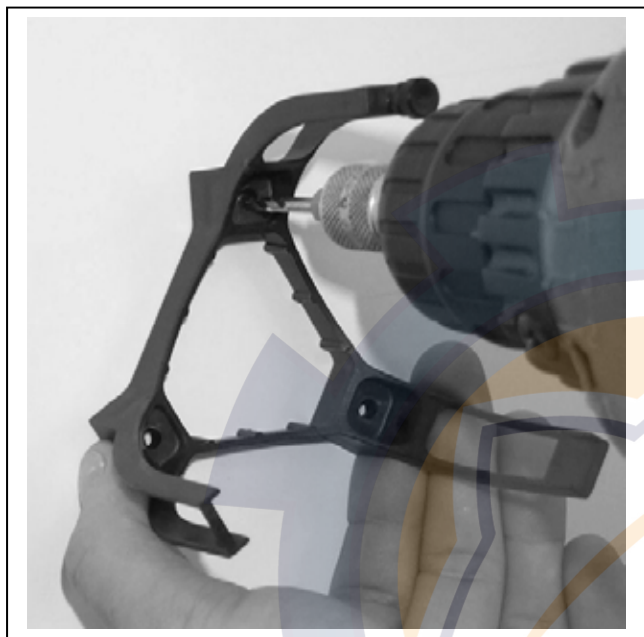


Fig. 8-a

Step one (Mounting the Sensor Ball)

Hold the mounting bracket in the desired position and drill through the holes into the mounting surface. (Be sure that the wire coming out of the ball can exit the ball straight down.) Tap if necessary. Install and tighten the three mounting screws as shown in *fig.8-a*

If you need to make a paper template for a drill pattern: The mounting holes are equally spaced on a 1.224 inch radius circle.



Fig. 8-b

Step two (Placing ball in bracket)

Place the ball, wires down, into the bracket and capture it by snapping the cage over the ball, sliding the tips of the cage between the ball and the legs of the bracket. Do the two legs without the thumbscrew first. Rotate cage upwards to catch the bracket with the thumbscrew. See *fig. 8-b*



Fig. 9-A

Step 3 (Adjusting Sensor Ball)

Readjust the ball if necessary and fix it in position by tightening the thumbscrew. See Fig 9-A. ***Make sure that the wires from the Sensor Ball are pointing straight down out the bottom; otherwise the sensor ball will not work properly. See Fig. 9-B***



Fig. 9-B



Fig. 10-a

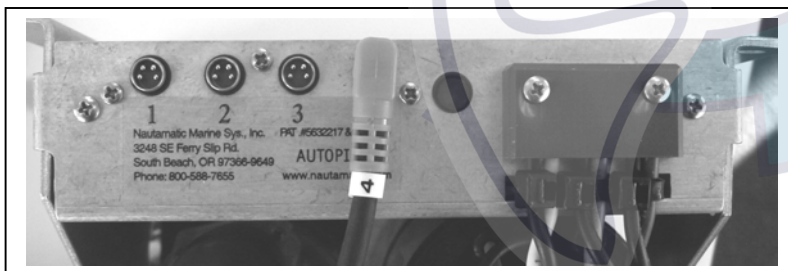


Fig. 10-b

Note: It is important to match your ECU wiring configuration to the picture. Just remember to always plug into matching numbers from the wire to the ECU.

Run the wire back to the E-H unit. The wire connector from the Sensor Ball is labeled number 4. It connects to the E-H unit at connector 4, as shown in *fig. 10-a or 10-b*. (this will depend on your ECU wiring configuration). When you plug in the connectors, the wires go at about a 45°-angle left of the numbers on the E-H unit (***fig. 10-a***) or at a 90° angle for ***fig 10-b***. Feel the connectors start before pushing it down.

Installation of the Deckmount and Tach

Step One: (Deckmount)

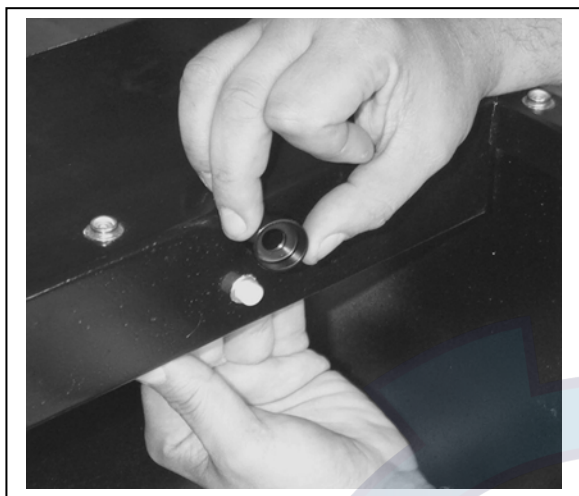


Fig. 11

If the material you wish to mount the Deckmount switch in is less than $\frac{1}{4}$ " thick: Drill a hole $\frac{15}{32}$ Diameter perpendicular to the surface. Unscrew the bezel from the switch and leave one washer on the neck. Put the switch button, with washer, through the hole from below. Screw the bezel on to the top and your done. Refer to Fig.11

If the surface you want to mount the Deckmount on is thicker than $\frac{1}{4}$ inch, Drill a $\frac{19}{32}$ hole through the surface. Unscrew the bezel from the top of the switch and remove the washers. Slide the switch all the way through the hole from the backside of the panel. Apply some silicone sealer/adhesive to the barrel of the switch. Screw the bezel, with or without a washer back onto the switch and slide the switch back into the hole. It may be necessary to tape or otherwise hold the switch in place until the sealer/adhesive sets. Alternatively, you can make a custom sheet metal bezel/mounting bracket for the switch.

Note: Route the cable for the tach on the opposite side of the kicker motor that you route the throttle actuator wire.



Step Two (Tach)

The Tach is the portion of the cable with a white antenna end. The antenna end needs to be installed into your outboard motor. The wire connector from the deck mount/Tach switch is labeled number 1. It connects to the E-H unit at connector number 1. Route the Tach portion of the wire from the E-H unit back to the motor. Remove the outboard cover. Route the cable through the grommets on the front of your motor, then route the cable around the motor to the spark plug wires. You will need to lay the white or antenna end of the cable along side of one of the spark plug wires in your motor. **Keep the antenna end at least 1" from either end of spark plug wire. Do not** stick the end of the wire into the boot of the spark plug wire. Use tie-wraps to attach the antenna end of cable to the Spark plug wire. (Fig. 11-A)
(After installation of your Autopilot, you will need to verify your tach. Please refer to page 31, paragraph 2 for more information).



Fig. 11-A

Installation of the Handheld/Remote



Fig. 12

Connect the Remote cable to the ECU unit at connector number 3. **Strain Relieve** the cable. One place to do this is the bottom right hand side of the ECU unit. *See Fig. 12.* This will help protect the Remote cable from being pulled out of the connector on the ECU unit and possibly damaging unit. If you need to drill a hole in the boat be sure to put a grommet in the hole to **protect** cable from the sharp edges.

Installation of the Cylinder Kit and Throttle Actuator

Refer to the manuals supplied with the throttle and steering cylinder kits, and install these parts before continuing with the procedures that follow. *If you do not use the throttle actuator, it is recommended that you coat #2 pico connector with a grease to protect it from corrosion.*

Connections

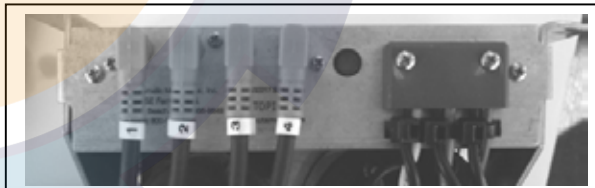
At this point, all electrical connections to the Electrohydraulic unit are complete. Some ECU wiring configurations are slightly different see *fig. 13-a and fig. 13-b* for your variation. **Verify these connections** as follows:

Deck mount #1	To ECU connector #1
Throttle #2	To ECU connector #2
Handheld #3	To ECU connector #3
Sensor Ball #4	To ECU connector #4

Fig.13-a



Fig.13-b



Battery Connection Installation



Now hook up the battery connections. **We recommend that you connect the battery cable directly to the battery.** Connect the ground side first. Connect the black wire to negative (-) side of the battery. Connect the orange wire to the positive (+) battery terminal.

Note: Do not be alarmed if connection sparks when connected to battery, you are charging a capacitor inside the unit.

Do not cut out or eliminate the fuse portion on your battery cable, it is there to protect your system and may void your warranty if removed.

If you unplug the battery cable be sure to replace the tie wrap around connectors to prevent them from separating.



Connect and Fill the Hydraulic System

Before you start.....

- As with all hydraulic systems, it is very important to keep any dirt or debris from entering the system.
- If you haven't already, *loosen the steering tension adjustment* on your motor to the minimum setting. The motor should turn very easily. (*If necessary refer to your outboard motor's owner's manual*).
- The fittings in the electro hydraulic unit (Pump unit) and the Cylinder are barbed hose fittings. It is important that you push the hose completely over the barbs. Use some fluid to lube the inside of hose before pushing them on. It will make the process slightly easier.
- This process may be a little messy so keep a few rags handy. Safety glasses are also a good idea.

Step One

Remove the **Left** side of the kinked clear shipping tube from the E-H unit. Keep the kinked clear tube (with the tie wrap) on the **Right** barbed fitting (It will act as a plug). Fig.A



Fig A

Step Two

Run a **continuous** section of black rubber hose from the **Left** E-H fitting, out the back of the boat to the cylinder and back into the boat to the pump. **Do not cut the hose at this time.** See.Fig. B



Fig. B

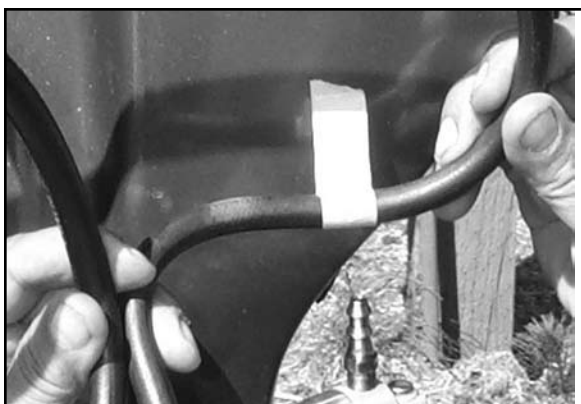


Fig. 14

Step Three

Arrange the hose at the cylinder end so that none will kink and they are hanging free. Put a piece of tape on the right hose at the cylinder end to identify it. You will need to know this when it's time to connect the hose to the cylinder. See Fig.14.

Step Four

Get into the boat close to the E-H unit. Bring the Remote Handheld, fluid, and some rags. Remove the screw that locks the E-H unit in place so that you can move the unit around. Remove the tank plug by unscrewing counterclockwise and remove. Note the tank has two fluid level lines on it. The upper line is the full line and the lower line is the low fluid line.



Fig. 15

Step Five (Purge Air)

Take the open end of the continuous loop of black hose, and insert it into the tank as shown in Fig. 15. Be sure that the other end of black hose is secure on the left barbed fitting on the E-H unit. Also make sure that the clear kinked hose is also secure on the right barbed fitting. (Use of tie wraps may be necessary) Turn the pilot on by momentarily pressing and releasing the deckmount switch. When the Stby LED quits blinking, press the top button on the remote (Auto/Stby) the Auto Led will be lit. Holding the tube in the tank press the **Left Straight Arrow**. Refer to fig. 15. The fluid level will go down. Let the button up and place system in **STBY** when the fluid is low and refill the tank. **(Do not press the Straight Right Arrow Button, you will blow the clear tube off the right side and create a hydraulic fluid mess)**

You may need to fill the tank several times. Keep the hose submerged in the tank fluid and keep pumping until bubbles stop appearing in the tank.



Fig. 15-a

Turn the system to standby by momentarily pressing the top button (AUTO/STBY) on the handheld. Turn the unit off by pushing in the deckmount button and hold until the lights are out (about to the count of 5). Remove the hose from the tank, keeping your thumb over hose to prevent air from entering or losing fluid. Insert the tank plug, fitting it securely into the top of tank. Tilt the fitting end of the E-H unit back and remove the kinked shipping hose from the E-H. Now push the rubber hose onto the right fitting pushing firmly until fully engaged over barbs. Install the Two (2) Hose clamps over the hose and barbed fittings at the manifold and tighten. See Figure 15-a.

You will need the clear shipping tube again in the next step so don't throw it away yet.

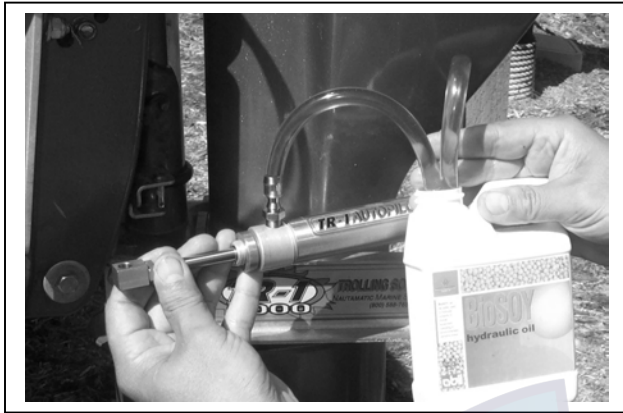


Fig. 16

Step Six (Fill Cylinder)

You will need the motor in the down position and the cylinder fittings pointing straight up. Disconnect the rod end of the cylinder from its mount. Find the kinked piece of tubing that you removed in step one. Remove the tie wrap and cut the tubing in half. Push one half on each cylinder barbed fitting. Open the fluid bottle. Insert pieces of tubing into the fluid. They need to go to the bottom of the bottle. Now hold the tubing in the bottle with one hand and pull and push the rod in and out of the cylinder until you stop seeing air bubbles in the hose. Refer to fig. 16

Slide the rod into the cylinder as far as it will go. Now remove the short clear hose from the cylinder and drain the fluid from the tubing into the bottle. Be sure both cylinder fittings are full to the top. Point the rod end of the cylinder toward the pin that engages it but leave it pushed into the cylinder.



Fig. 17

Step Seven (Correctly connect the hose)

At the cylinder, kink the black hose (bend it over sharply and use a tie wrap to pinch hose shut). See Fig. 17. Cut the hose as shown just above the tie wrap and keep a thumb over the right side to keep the fluid in the hose. Keep the hose full to the brim and push the right hose (hose that has tape) onto the right cylinder fitting as shown in Fig.17-A

Cut the tie wrap on the left hose and insert it on the left fitting on the cylinder as shown in Fig.17-B. Reconnect the cylinder rod end.



Fig. 17-A

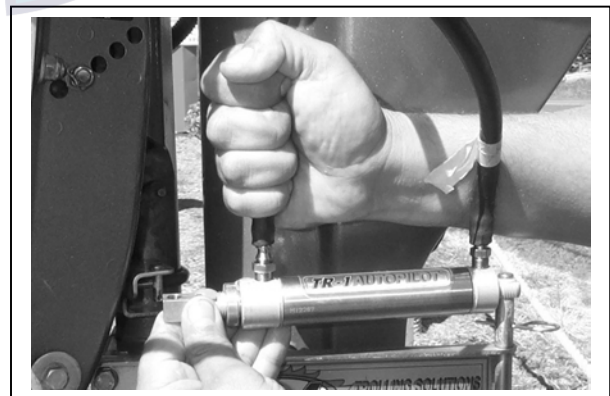


Fig. 17-B

Step Eight (Check hose fit)

Check to see that the hose is free to move back and forth with motor. Tie wrap as necessary to hold hose in place. See Fig. 18

Step Nine (Hose Clamp)

Place hose clamps over hose and fittings at cylinder end. Fig. 18-a

Step Ten (Top off the system)

Manually turn the motor back and forth several times. Air bubbles trapped in the tubing may cause the fluid level in the tank to surge when the tiller is moved fast. The more the tiller is cycled back and forth, the more air is purged from lines. Top off the tank with fluid when the surge is reduced. Replace the tank plug. Remount the pump unit following the instructions on page 10, making sure all screws are tight.



Verify Proper Installation

Press the deck mount switch to turn the system on. Put the unit in **AUTO** mode. Press and hold the Straight **Left Arrow** button on the Remote. The kicker will steer to the port. Press and hold the **Straight Right Arrow** button on the Remote and the kicker will steer to starboard. Turn the motor several times in each direction to verify that hose connections are tight and that you have no binding of hoses or cables.



Get in position to see the kicker carburetor and the throttle actuator you installed, then press and hold the **Up Arrow button**. The actuator should open the carburetor throttle. Press and hold the **Down Arrow button**. The actuator should run the carburetor to idle. Pushing and releasing these buttons quickly moves the throttle by small amounts. Holding them down changes the throttle by large amounts. Move the throttle to mid-travel and then press the **IDLE/RES** button. The throttle should go to idle. Press the button again and the throttle should go back to the mid-travel position.

!!!! You will need to calibrate the Compass of your Autopilot, and will need to tune the Autopilot to your boat and motor configuration. Please see page 33, adjusting your Autopilot for Heading Hold operations on your Boat.

GPS Connections

Check to see that your GPS transmits NMEA 0183 messages \$GPRMB (RMB), and \$GPRMC (RMC) before you hook your GPS to the autopilot. These are the messages the autopilot must receive in order to steer with the GPS. Your GPS NMEA output wires will usually be bundled with other conductors in the GPS cables. Look in your GPS manual for instructions relating to NMEA output from the GPS to other devices. The GPS manual should identify two wires that are named something like NMEA out (+) and NMEA out (-). Connect the NMEA out (+) to the red (+) and the NMEA out (-) to the white (-) conductors in the stub cable with the blue tip at the Sensor ball. You will need to strip some of the jacket from the blue tipped cable in order to get to the red and white conductors. 22 or 24 gage twisted pair wiring is recommended for connecting this circuit. (See page 23 for more information on GPS.) You will need to calibrate your compass and Set North in order for GPS functions to work. See pages 23 & 35

Introduction to Operation and Adjustments

This section of this document provides you with information that will let you take advantage of your TR-1 Gold autopilots' capabilities. We have made every effort to minimize the pain in getting you up to speed as a user of the TR-1, however, programmable devices such as your TR-1, are often difficult to learn to use and to program. We recommend that you do not take your fishing tackle with you on your first trip with your new autopilot. Take a few hours on a nice day to get your system setup and familiarize yourself with its operation, then your first fishing trip with the unit will really have you smiling.

This manual is laid out in sections that are, as best we can make them, self contained. We start with the features and functions available and fundamentals of how the system works, then how to operate the basic functions, and finally how to get into the fine adjustments.

Some of you will find that this manual is lacking in depth and clarity, and for this we apologize. Please do not hesitate to call us for interpretation and other help you may need.

System Functions And Features

The TR-1 is, at its core, a heading hold autopilot. It steers the kicker to maintain a constant magnetic heading. The autopilot measures magnetic heading with a flux gate compass and receives rate of turn information from a vibrating beam rate sensor (gyroscope). The autopilot computer forms a rudder rate command from a combination of the compass, gyro, and engine tachometer signals. This rudder rate command is calculated and sent to the pump controller in the electrohydraulic unit electronics 20 times each second. The pump control electronics servos the pumping speed and direction to match the rudder rate command from the autopilot.

The autopilot is designed to disconnect from the steering cylinder when it is off or in standby. It does this with a bypass valve that shunts fluid from the steering cylinder around the pump when the bypass valve is open.

Beyond the basic heading hold function, the autopilot provides for several other modes of automatic and manually controlled steering functions. These are listed below.

1. Rudder Command / Attitude Hold (RCAH). RCAH is the primary means for changing the boats heading manually.
2. Remote steer. Remote steering is used for electrically steering the kicker without feedback from the gyro or compass.
3. Step turns. The autopilot will execute predetermined fixed angle turns in this mode.
4. Circles. The autopilot will turn in circles of predetermined duration.
5. Zigzags. The autopilot will steer a zigzag course with predetermined angle and duration.

6. Man Overboard. The autopilot will execute a turn to the reciprocal course and pass near the maneuver initiation point.

7. GPS steering. *(Some GPS units may not support these features.)*

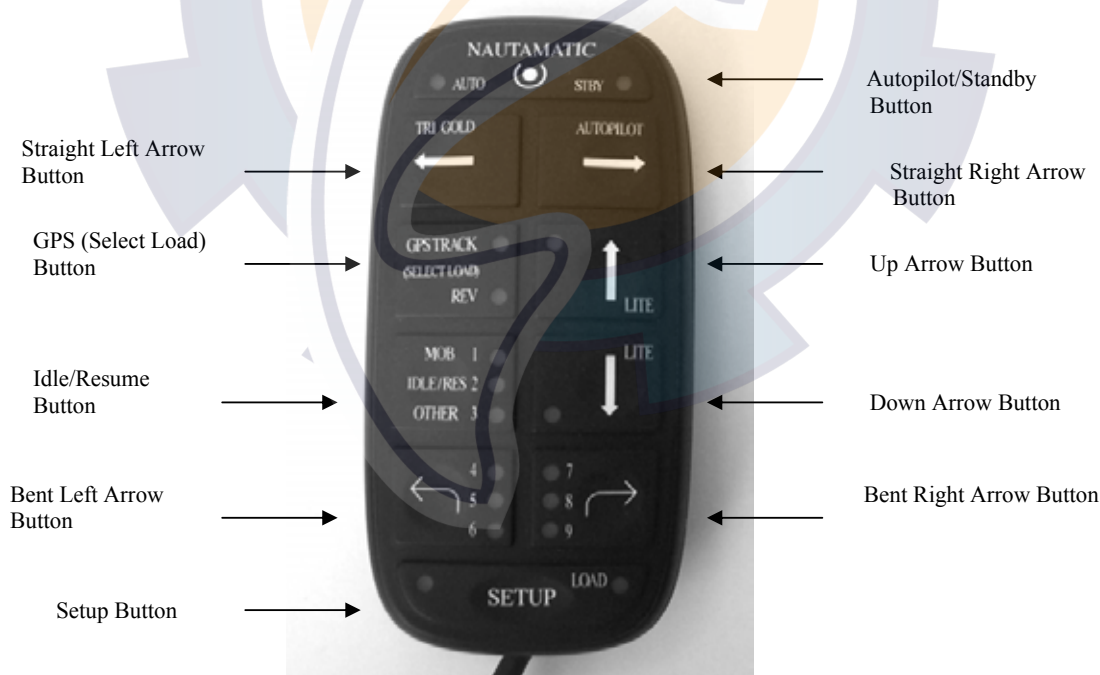
- 7a. The autopilot will steer to a waypoint or series of waypoints.
- 7b. The autopilot will orbit a waypoint.
- 7c. The autopilot will steer a 3 leaf clover pattern over a waypoint.
- 7d. The autopilot will steer a spiral search pattern around a waypoint.
- 7e. The autopilot will steer to constant course over ground.

8. Reverse. The autopilot will attempt to execute any of the above steering functions while the boat is backing.

The TR-1 system includes an electric throttle mechanism for remote control of the kicker throttle valve. The throttle butterfly valve is actuated by a lead screw and stepper motor. The stepper advances or retracts the lead screw in 1/1000 inch steps as commanded by the remote control pushbuttons. On system power down, the stepper is commanded to take the butterfly valve to its' closed throttle position. The throttle system has an Idle/Resume feature that provides for single button push reduction of throttle to idle and subsequent button push resumption of the initial RPM.

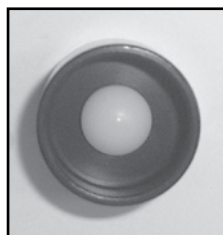
Operating The System

Most of the operation of the autopilot is accomplished through the remote control and the deckmount switch. To make things easy to talk about we will name the buttons as shown in the picture of the handheld/remote below.



Almost all of the buttons in the systems have multiple functions, and many functions are accomplished by button push sequences or by pushing more than one button at a time. The steering and throttle modes are not all available simultaneously. The **Idle/Resume**, **Bent Left Arrow**, and **Bent Right Arrow** buttons are sometimes referred to as “special function” buttons in the following text.

Power On/Off (Deckmount Switch)



Turn power on by pressing and releasing the **Deckmount** switch. Turn the power off by pressing and holding the switch down until the **Deckmount** switch light has extinguished (about four seconds).

Power on is indicated by illumination of the **Deckmount** switch button and the STBY LED on the Hand Held.

Both the **Deckmount** switch light and remote STBY LED will blink for about 30 seconds after turning power on. During this 30-second time, the pilot computers are running self-test and starting up the compass and gyroscope. No autopiloting operations are available during this start up period. After the startup period the STBY LED will stay illuminated, without blinking, as long as the system remains in standby mode.

The deckmount switch can also be used to switch the unit from standby to autopilot.

Engaging Heading Hold (Engaging Autopilot)



The **Auto/Stby** button on the handheld engages and disengages autopilot steering. The **Deckmount** button performs the same function after the pilot is powered up.

When the button is pushed to go into Auto mode, the pilot captures the compass heading and subsequent moves the rudder to hold that heading. The LED next to Auto will illuminate when The autopilot is engaged. You should be steering your boat on a constant heading at the time you Press the Auto/Stby button.

Change Heading with Remote Steer

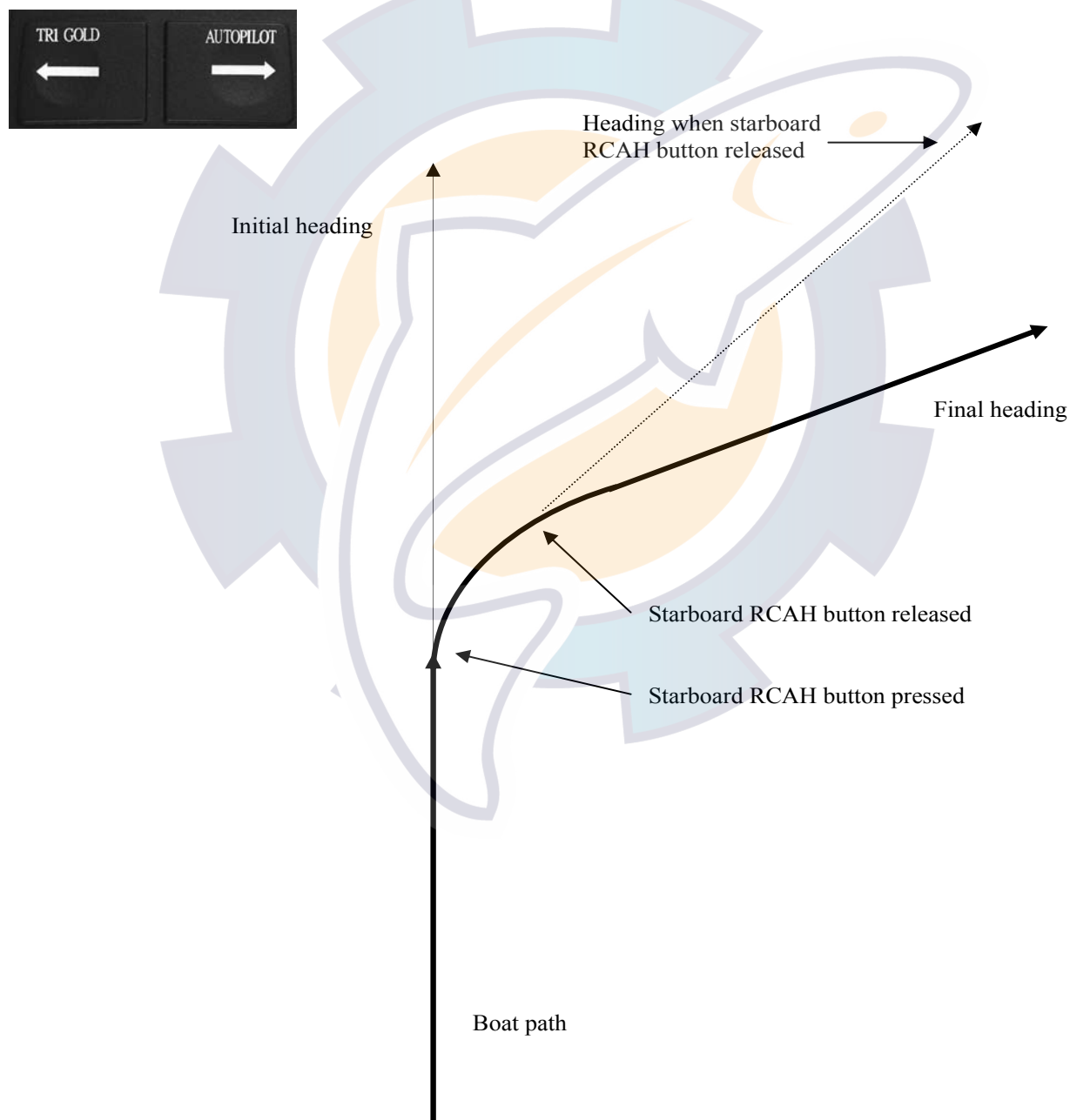


If you program the **Bent Right Arrow** and **Bent Left Arrow** buttons for Remote Steer, when one of these buttons is pushed, the rudder is directly controlled by these pushbuttons until a **Straight Right Arrow** or **Straight Left Arrow** button is pushed to reengage the pilot or the system is returned standby.

(In remote steer, (autopilot) heading hold is not engaged **and will not lock on to a new heading until one of the straight arrows are pressed to take it out of remote steer.**)

Change Heading While in Autopilot (RCAH)

You can steer to a new heading with the **Straight Right Arrow** and **Straight Left Arrow** buttons. Momentary presses of either of these buttons will cause the pilot to alter the heading by one degree per press. For example, pressing the **Straight Left Arrow** button five times will cause the heading to be changed by 5 degrees to the port. Holding either of these buttons down causes the pilot to turn the rudder so as to make a port or starboard turn. The rudder turns as long as the button is held down or until the rudder reaches the end of its travel range. When you release the button, the autopilot will move the rudder to stop the boat from turning. When the turn is stopped, the autopilot captures the compass heading and then moves the rudder so as to maintain this heading. An example RCAH turn is shown in the figure below.



GPS

The GPS steering functions are not guaranteed to work with all GPS systems. Each manufacturer of GPS equipment puts his own spin on how to assemble the data on the NMEA data bus. Sometimes the data on the bus will not conform to the needs of the autopilot. The autopilot expects to see, at least, the NMEA data sentences \$GPRMB and \$GPRMC at 4800 baud. These sentences are the minimum recommended data to be transmitted when there is an active waypoint. Some GPS systems do not conform to this NMEA specification.

Almost all GPS systems truncate the cross track error data to 0.01 NM resolution, this means that the autopilot cannot be expected to stay on track any closer than 60 to 120 feet. There is a large discrepancy between manufacturers in how they warn the user when the navigation fix is compromised. Some systems alert the NMEA bus listener immediately upon position fix loss but wait 30 seconds to a minute to warn the operator on the GPS display. This is disconcerting to the user because his autopilot drops out (The autopilot stops using the GPS steering command immediately upon receiving a warning from the navigator.) of GPS steering and there is often no indication on the GPS display that anything is wrong with the GPS. Some manufactures wait 30 seconds to alert the user via the display and the devices on the NMEA'S data bus when the position fix is broken. The worst performance in all the GPS units we have tested occurs when a satellite is occluded by the horizon; we have seen steering errors on the order of several hundred feet in these situations.

The autopilot cannot fix steering errors that are GPS generated. Keep an eye on where you are going when you couple the GPS to the autopilot.

When the autopilot is taking steering commands from the GPS, the **GPS** (Select Load) LED will be lit solid. If the autopilot detects a GPS problem it will blink this LED. Press any button to extinguish the blinking LED.

Set North

To run a GPS course requires that the autopilot compass is in agreement with the GPS's course estimate. You need to set North with the pilot in standby mode. Do not set North except in calm sea's and un-accelerated conditions. You should be running at a reasonably high speed, it won't hurt to be running on plane with your main engine. With your GPS turned on and setup code 48 selected, press and hold the **GPS (Select Load)** button.

If the **Up Arrow** LED illuminates, this means that your GPS connection is not sending course information to the autopilot correctly. You must point your boat north and then press and release the **Deckmount** switch to set compass north.

If the **Up Arrow** LED does not illuminate, press and release the **Deckmount** switch to set compass north. In this case you do not need to be pointing north-you only need to be going in a straight line.

Your pilot will power down after north has been set.

Course Overground Hold

If you press and release the **GPS** (Select Load) button when the autopilot is in heading hold and the GPS does not have an active route, the pilot will maintain the GPS course over ground instead of the magnetic heading. Be aware that the course over ground calculated by the GPS is erratic at low speeds.

All the special function and turn buttons will continue to behave as if you are in normal heading hold. If you use any of the normal turning buttons, go to waypoint and course over ground hold are terminated.

Steer To Waypoints (GPS Steering)

If you press and release the **GPS** (Select Load) button when the autopilot is in heading hold and the GPS has an active route, the pilot will steer to the selected waypoint.

If you are more than 1000 ft. off the courseline the pilot will steer directly at the waypoint and not try to remove crosstrack error.

Return to heading hold by pressing one of the Straight Arrow buttons.

Orbit Waypoint (GPS Steering)

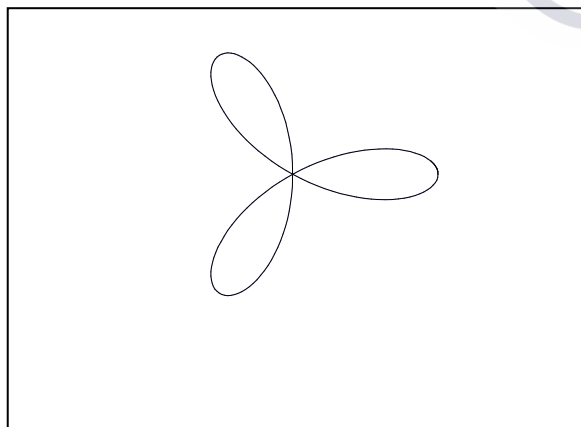
The autopilot will orbit the waypoint you have activated in your GPS, with the waypoint to your starboard side if you press the **Bent Right Arrow** button when the **GPS** (Select Load) LED is lit and the special function Orbit Wpt has been enabled. The waypoint will be on your port side if you use the Bent Left Arrow button.

The orbital radius is the distance from the waypoint at the time you press one of the bent arrow buttons.

Return to heading hold by pressing one of the Straight Arrow buttons.

Three Leaf Clover Pattern (GPS Steering)

The cloverleaf pattern is intended for use when you wish to repeatedly pass over a point where you think fish may be holding. You must mark the location of the cloverleaf stem with a waypoint in your GPS. Once the waypoint is saved, select “go to” this waypoint on your GPS. From heading hold, press and release the GPS (**Select Load**) button. The pilot will start maneuvering toward the waypoint. If you have selected clover leaf pattern as the special function for the Bent Arrow buttons, pressing either **Bent Arrow** button will start the boat on the cloverleaf pattern. If you used the **Bent Right Arrow** button the cloverleaf will be traversed by always turning to port. The length of one of the cloverleaves is programmed with setup code 29. It is adjustable in length from 500ft to 6000 ft in 100 ft increments.

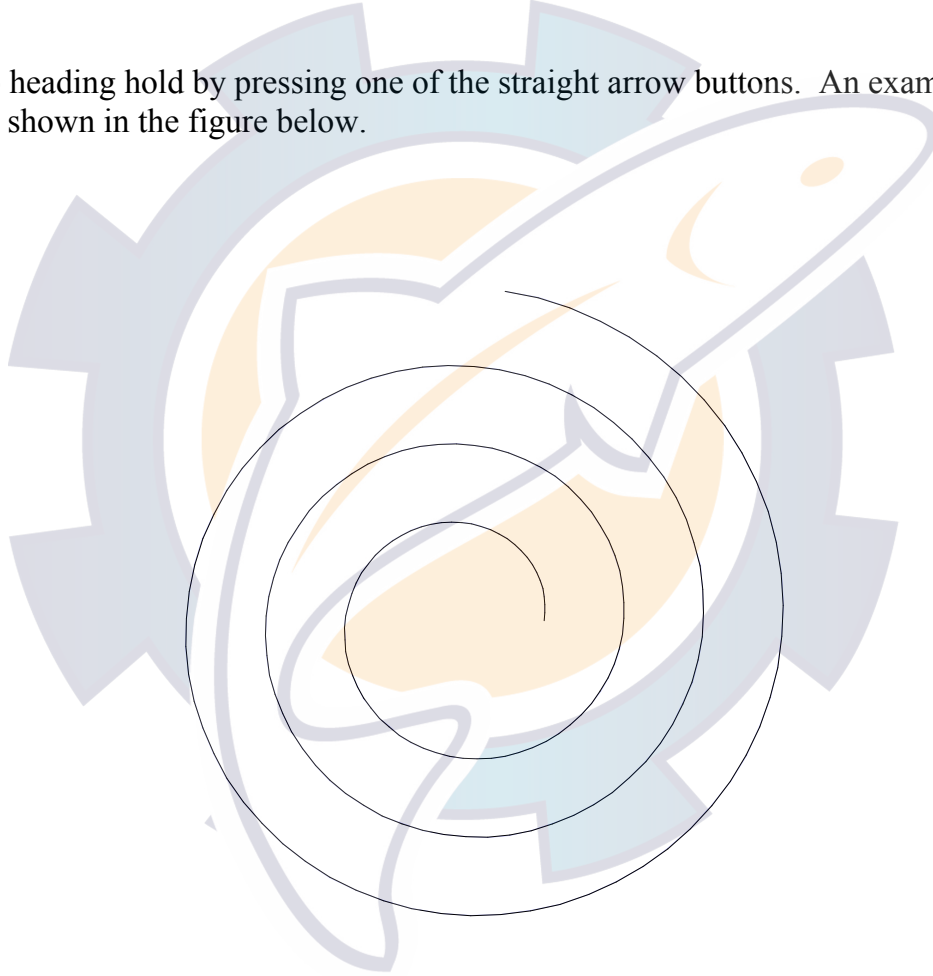


Return to heading hold by pressing one of the Straight Arrow buttons. An example of the Clover-Leaf pattern is shown in the figure to the left.

Search Pattern (GPS Steering)

To do an outward spiraling search from a waypoint, setup the special function buttons for search patterns. (See page 28 Selecting Special Functions) When you are near the waypoint you want to search from, select “go to” this waypoint on your GPS. With the pilot in heading hold, press and release the **GPS** (Select Load) button and then press and release one of the Bent Arrow buttons. If you pressed the **Bent Right Arrow** button, the waypoint will remain on your starboard side as the spiral search unwinds. The spacing between the spiral laps is set with setup code 249.

Return to heading hold by pressing one of the straight arrow buttons. An example of the search pattern is shown in the figure below.



Reverse

The autopilot will attempt to perform any of its steering functions when the boat is backing in reverse gear. To engage the system in reverse: 1) Start from Standby. 2) Press and hold the **GPS (REV)** button. 3) Press and release the **Auto/Standby** button. 4) Release the **GPS (REV)** button.

Circles

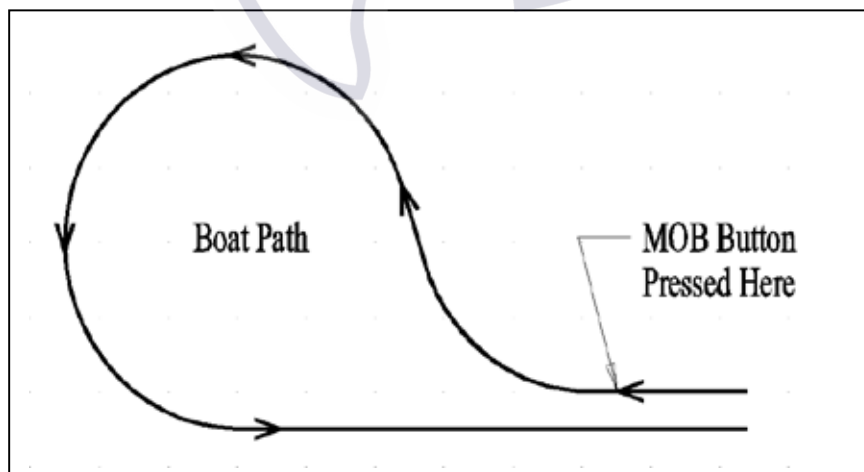
If you program the **Bent Right Arrow** and **Bent Left Arrow** buttons for Circles, pressing the **Bent Right Arrow** button will cause your boat to be driven in a clockwise (from above) circle with a lap time between 1 and 90 minutes (programmable). The **Bent Left Arrow** button will cause counterclockwise turns. You can exit the circle and run straight anytime by pressing either the **Straight Right Arrow** or **Straight Left Arrow** button.

Step Turns

If you program the **Bent Right Arrow** and **Bent Left Arrow** buttons for Steps, when one of these buttons is pushed, the pilot will execute a port or starboard turn. The turn will terminate when the programmed step angle is reached. The step angles are programmable from 1 to 90 degrees. Multiple pushes of these buttons will result in a turn through an angle equal to the sum of the angles per push. For example, if you have programmed the pilot for 10 degree steps, five pushes of the **Bent Right Arrow** button will turn you 50 degrees to starboard. 180 degrees is the maximum turn sum.

Changing Heading With MOB

The Man Overboard (MOB) function causes the boat to turn to starboard for a while then turn to port until the reciprocal course is established, with the goal of running alongside the point where the MOB button was pushed. The boat path will be as shown in the figure below.



Throttle Up/Down



Increase throttle by pressing the **Up Arrow** button. Decrease throttle by pressing the **Down Arrow** button. The electric throttle runs in parallel with the tiller throttle, this means that you can't reduce the RPM with the electric throttle if the tiller throttle is set high. It is best to always run with the tiller throttle set to idle. *Be careful to set the electric throttle and tiller throttle to closed position before starting your outboard.*

Idle/Resume Feature

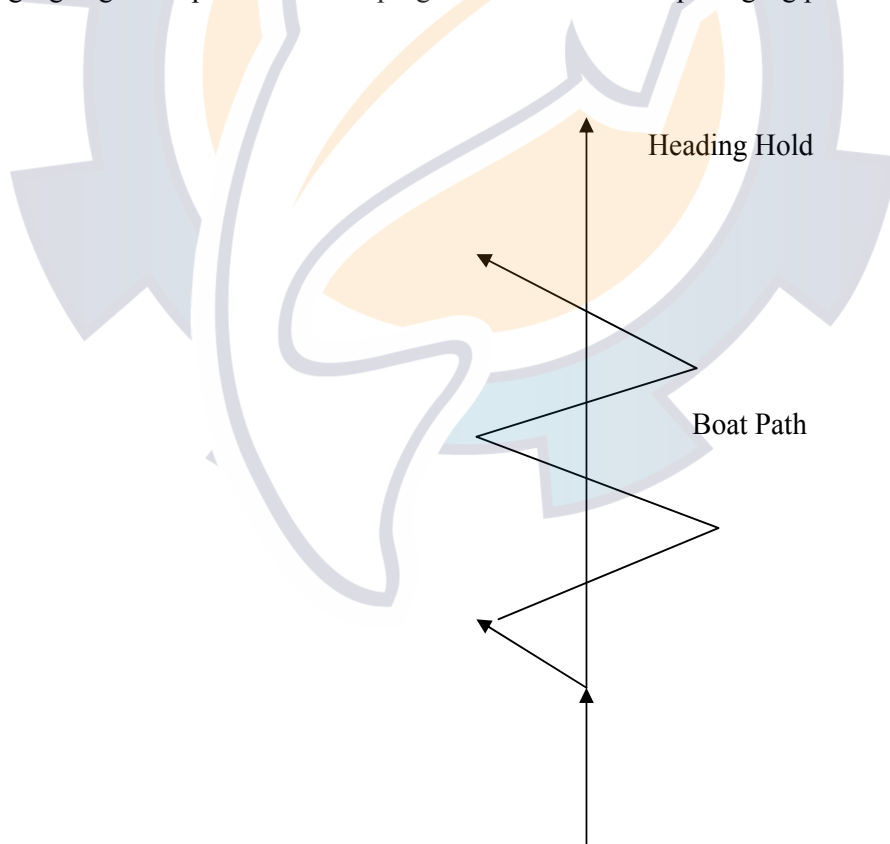


Automatic idle and resume is accomplished by pressing the **Idle/Resume** button. If the throttle is set higher than idle, the Idle/ Resume function will take the engine to idle. If the throttle is sitting in the idle position, the Idle/Resume function will return the throttle to the last "above idle" position. The **Idle/Resume** button must be programmed to perform Idle/Resume and not MOB or Zigzags.

Change Heading Using Zig-Zags



If you program the **Idle/Resume** button for Zigzags (other), then when you press the **Idle/Resume** button the pilot will begin to zigzag about the heading you were on when you pressed the button. The zigzag angle and period are both programmable. An example zigzag path is shown in the figure below.



Selecting Special Functions

When you select special functions, by the methods described below, you are simply choosing which function is to be executed by the pilot when you push one of the three special function buttons.

The **Idle/Resume** button is programmable to provide either Idle/Resume or MOB or Zigzags (other). The **Bent Left Arrow** button is programmable to provide either Steps or Circles or Remote Steer. The Bent Right Arrow is used to program the pilot for waypoint Orbiting or clover leaf or search steering in conjunction with your GPS.

To change the functions of these programmable buttons, follow the directions below.

1. Autopilot must be in Heading Hold or Standby Mode before selection process can start. (AUTO LED solid on or STBY LED solid on. No other LED's on.)
2. Press and hold **Setup** Button. Three LED's next to the numbers 1 through 9 will illuminate, indicating which (3) special functions are programmed to operate. For example, if LED 2, 4, and 7 illuminate, your system is programmed to do: 1) Idle Resume when the **Idle/Resume** button is pressed. 2) Step turns to port when the **Left Bent Arrow** button is pressed. 3) Step Turns to starboard when the **Bent Right Arrow** button is pressed. 4) Orbit a waypoint clockwise when the **Bent Right Arrow** button is pressed *and the system is tracking a GPS signal*. 5) Orbit a waypoint clunterclockwise when the **Bent Left Arrow** button is pressed *and the system is tracking a GPS signal*.
3. Select the Special Function you want to use by pressing and releasing the **Idle/Resume** and **Left Bent Arrow** button until the appropriate LED's are lit. (See the Table below for Special Function Indicators.)
4. Release the **Setup** Button.
5. **To make the selected Special Functions into start up defaults:** Press and release the **Setup** button and verify the setup LED is lit. Then press and hold the **GPS** (Select Load) button. Verify that the Load LED is lit. Then press and release the **Deckmount switch**, then release the **GPS** (Select Load button). (**This Locks in your selections**)
6. **To illuminate the keypad** on the remote for nighttime operation: Press and hold setup and press the up arrow. Repeat to turn the back light off. The down arrow will toggle the brightness of the orange LEDs between bright and dim when the setup button is held down.

Special Function Indicator LED Numbers

1	MOB
2	Idle/Resume
3	Other

4	Steps
5	Circles
6	Remote Steer

	GPS Steering (GPS connection required)
7	Orbit Wpt.
8	3 Leaf Clover
9	Search

How to Make System Changes with Setup

1. Autopilot must be in Heading Hold or Standby Mode before selection process can start. (AUTO LED solid on or STBY LED solid on. No other LED's on.)
2. Press and release the **Setup** Button. The Setup LED will illuminate to indicate the system is ready to take setup commands (button pushes).
3. Make selection of the Setup Function you want to use by pressing and releasing the buttons labeled 1 through 9 until the appropriate LED's are lit. (See the Table below for Setup Codes.)
4. Increase an adjustable parameter one step by each press of the **Up Arrow** button. When the parameter is adjusted to its maximum value, the Up Arrow LED will light. The parameter is adjusted and is in use by the autopilot immediately.
5. Decrease an adjustable parameter one step by each press of the **Down Arrow** button. When the parameter is adjusted to its minimum value, the Down Arrow LED will light. The parameter is adjusted and is in use by the autopilot immediately.
6. You can stay in Setup and adjust more than one parameter.
7. Compass Calibration, and resetting to factory defaults are setup conditions that take the system over and restart the autopilot computer. The button sequences for their operation are given in the Table of Setup Codes below.
8. To view the operating value of an adjustable parameter, enter its code per the Table of Setup codes, then press and hold the **GPS** (Select Load) button. The LED on the **Up Arrow** button will blink the number of tens the parameter is set to and the LED on the **Down Arrow** button will blink the number of ones the parameter is set to. For example if the parameter is set to a current value of 15, the Up Arrow LED will blink once and the Down Arrow LED will blink 5 times to indicate the parameter is set to 1 (blink) X 10 + 5 (blinks) X 1. Of course, when a parameter is adjusted to its minimum or maximum value, the appropriate LED stays on solid per 4. and 5. above.
9. For temporary use of the adjusted parameters: Press and release the **Setup** button to exit the setup mode.
10. **To make the selected Special Functions into start up defaults:** Press and release the **Setup** button and verify the setup LED is lit. Then press and hold the **GPS** (Select Load) button. Verify that the Load LED is lit. Then press and release the **Deckmount switch**, then release the **GPS** (Select Load button). **(This Locks in your selections)**

Table of Setup Codes

Tachometer Codes

Setup Action	Code #	Range of Settings or Responses	Default
Stby Safety Monitor	349	2 settings on, off, defaults to on every power up	on
Tach on/off	34	2 settings on, off	on
Show RPM	36	Hold Down <i>Select Load</i> Button: 1000's blink on up Arrow 100's blink on down Arrow	

Throttle Codes

Throttle Speed	24	1 lowest speed, 10 highest speed	5
Throttle Delay	25	1 least delay, 10 most delay	5

Hydraulic Codes

Reverse Hoses	259	2 settings normal up arrow lit, reverse down arrow lit	normal
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Automated Setup Codes

Calibrate Compass	47	Hold Down <i>Select Load</i> Button, press and release Deckmount Button to start Calibration Process	
Load Factory Compass	49	Hold Down <i>Select Load</i> Button, press and release Deckmount Button to reload factory Compass Calibration	
Load Factory Pilot	59	Hold down <i>Select Load</i> Button, press and release Deckmount Button to Reload Factory Pilot Settings	

Special Function Setup Codes

Degrees per Step	6	10 choices/1,2,3,4,5,10,15,30,45,or 90 Degrees	15
Circle Time	7	10 choices/ 1,2,3,4,5,10,,15,30,45,or 90 Minutes	5
Zig-Zag Amplitude	8	10 choices 5 to 50 degrees by 5's	30
Zig-Zag Period	9	20 choices 1 to 20 minutes by 1's	3
MOB overshoot	28	1 most overshoot command, 40 most undershoot command	20
Cloverleaf Length	29	500 ft to 1000 ft by 50 ft increments	1000
Search Spacing	249	50 ft to 1000 ft by 50 ft increments	50

Navigation Function Codes			
Setup Action	Code #	Range of settings or Responses	Default
Navigation Gain	15	1 lowest gain, 73 highest gain	42
Navigation Trim Gain	16	1 lowest gain, 73 highest gain	49
Use Synthetic XTE	37	2 settings on, off	off
Change Sign of XTE	18	2 settings on, off	off
Use Magnetic North	39	2 settings on, off	on
Set North	48	Hold Down Select Load Button, press and release Deckmount Button to set north See Notes code #48	
Enable Checksums	347	2 settings on, off	on

Fine Tuning Codes			
Seastate Filtering	1	1 least responsive steering, 5most responsive steering.	5
Rudder Gain	2	1 Lowest gain, 60 highest gain	22
Counter Rudder Gain	3	1 lowest gain, 60 highest gain	37
Speed Schedule	35	4 settings 1 aggressive, 2 moderate, 3 mild, 4 weak	4

Code 1 Sea State Filter.

If the Autopilot seems to be too active in rough water (the kicker motor is overactive) but works perfect in calm water, adjusting the *Sea State Filter* may help. Factory default sets this code at the top of its range (4) which is most active (least active is 1) . Most of the time you will want to run with this parameter at the the top of its range. To decrease the autopilots sensitivity in rough water 1) Press and release [SETUP] on the handheld, the setup LED will be lit. 2) Press the [IDLE/RES] button and light up the number 1 LED .

3) Press the *down arrow button* to decrease the autopilots sensitivity. **Note: When the autopilot is shut off, the autopilot will return to its factory default setting unless the setting is saved See page 28, Step 5.**

Codes 15 & 16.

The best way to tune GPS tracking is to start with the trim gain at its minimum and set the coupling gain as high as it can be set without causing oscillations around the course line capture.

Code 18.

Changes the direction to steer to courseline. Some GPS' steer the wrong way, turn this parameter on to fix the GPS problem.

Code28.

The man overboard maneuver can be tuned to run over the target at any given speed, but may miss by a distance at another speed. If you choose to use this function, tune it with these two tuning codes. If the man passes on your starboard reduce code 28.

Code 35.

Since the boat dynamics change with RPM the autopilot retunes itself as it sees the RPM change. Most boats will work well with the mild setting. The easiest way to set the speed schedule is to first get tuned up and working well at low speed, then run at high speed. 1) If steering response is sluggish, increase code 35. 2) If the steering response is oscillatory, decrease code 35.

Code 37.

Turning this parameter on may provide tighter course line tracking when you are within one mile range of a destination waypoint.

Code 39.

If you set your GPS to use true headings, turn this parameter off.

Code 48

To run a GPS course requires that the autopilot compass is in agreement with the GPS's course estimate. You need to set North with the pilot in standby mode. Do not set North except in calm sea's and un-accelerated conditions. You should be running at a reasonably high speed, it won't hurt to be running on plane with your main engine. With your GPS turned on and setup code 48 selected, press and hold the **GPS (Select Load)** button.

If the **Up Arrow** LED illuminates, this means that your GPS connection is not sending course information to the autopilot correctly. You must point your boat north and then press and release the **Deckmount** switch to set compass north.

If the **Up Arrow** LED does not illuminate, press and release the **Deckmount** switch to set compass north. In this case you do not need to be pointing north-you only need to be going in a straight line.

Your pilot will power down after north has been set.

Code 259.

If you find that you have connected the hydraulics backwards, use this code to electronically "swap" the hoses.

Code 347.

If RMB and or RMC messages from the GPS aren't received by the pilot, it may be due to a message formatting error. If you turn this setting off, the pilot may still be able to use the data. *The integrity of the data used by the pilot in this condition is compromised.*

Code 349.

The autopilot will automatically down mode to standby after a period of time of sensing no RPM. From the kicker (This is done to avoid a melt down of the pump motor in the case the unit was inadvertently left on when the boat was parked.) To stop it from down moding turn this code off. This parameter cannot be set to off in permanent memory, therefore, must be used on a as need basis.

Code 369. *If you hold down the GPS (select Load) button with this code lit, the software version number will blink out on the up and down arrow LED's*

Compass Calibration and Tuning your Autopilot

Your autopilot needs to be “tuned” to your boat and motor configuration. This is the most difficult part of getting your pilot running the best it can. Have patience and don’t even try to do this until you have some time on a nice calm day. Follow the directions below.

1. **Calibrate your compass.** The autopilot compass is made with a fluxgate. Like all compass installations, fluxgate installations are susceptible to local magnetic disturbances that will cause erroneous heading outputs. The autopilot computer can detect and correct deviations caused by magnets and iron materials around the fluxgate-if the earths’ magnetic field near the compass isn’t too distorted. You should only calibrate the compass on calm water. Stay away from large steel structures. Calibration will not work right if you try to do calibration with your boat on the trailer because the trailer is made with iron. Compass calibration is not absolutely required, but GPS functions will work best with the compass calibrated (North needs to be set also for GPS functions.) Find some smooth water where you can drive in circles without running into anything.

With the pilot in **Standby** mode;

- Press and release the [**Setup**] button then enter code 47. (Press and light up 4 LED and 7 LED)

- Press and hold the [**Select Load**] (**GPS**) button. While holding the Select Load button down, press and release the **Deckmount** Switch, then release Select Load. The Up Arrow LED will turn on.

- Now drive in a straight line and watch for the Up Arrow LED to start blinking. When it starts to blink, begin turning to starboard. Turn at a rate that makes a full 360 degree turn in 30 seconds to one minute. You will need to make about 3 to 4 full turns. Continue to turn until the Up Arrow and Down Arrow LED’s both light up. They will stay lit for about five seconds and then the system will completely power down. Your compass is now calibrated.

***If Up and Down Arrows both continue to blink and does not power down, the compass Calibration has failed.** Check for magnetic disturbances in the space around the compass and try to calibrate again. Make the turn as smooth (un-accelerated) as you can. You will need to shut down the Autopilot and restart it before recalibrating.*

2. **Verify your tachometer** is functioning properly:

- Press and light up the [**Setup**] button and enter code 36. (Press and light up the 3 LED and 6 LED)
- Press and **hold** the [**Select Load**] (**GPS**) button and you should see the Up Arrow and Down Arrow LED’s blink your RPM.

For example: when the Up Arrow LED blinks 2 times and the Down Arrow LED blinks 5 times your engine is running at 2500 RPM. The autopilot tachometer system has a lower limit setting of 500 RPM, so if your motor is running more than 500 RPM and you see 500 on the remote, you are not receiving the tach signal. Move your tachometer cable closer to your spark plug (do not put it into the boot) if you don’t see the correct RPM’s on your remote. Also try moving it to the other spark plug wire, then try it again.

3. **Tune the feedback gains.** Start from [Standby] mode. (The STBY light should be lit on the handheld.)
 - Press the [Setup] button and press and light up code 2 (Number 2 LED on the handheld) - this is the rudder gain adjustment code. Run your boat in a straight line at 1/3 to 1/2 full speed and engage the pilot by pressing the **Auto/Stby** button. **Don't expect to see good performance yet.**
 - a) If the boat heading and kicker start oscillating, turn the Rudder Gain (code 2) down by pressing and releasing the [**Down Arrow**] button as many times as required to calm the oscillation.
 - b) If the boat is making slow "S" turns, turn the Rudder Gain (code 2) up by pressing and releasing the **UP Arrow** button until the boat heading and kicker start to get "twitchy" then back down on the Rudder Gain a few clicks.

Now enter and light up code 3 on the handheld, this is the Counter Rudder Gain adjustment code.

- If the boat heading has slow oscillations, increase the Counter Rudder Gain.

Alternately adjust the Rudder Gain and Counter Rudder Gain until the boat is steering well.

Now initiate some turns with the [**Straight Right Arrow**] or [**Straight Left Arrow buttons.**] Hold the button down only long enough to move the kicker 30 degrees or so, then let up. The pilot will try to stop the turn smoothly and then maintain the new heading.

- a) If the pilot doesn't stop the turn very well, decrease Counter Rudder (code 3) gain and increase Rudder Gain (code 2).
- b) If the pilot moves the rudder too far when stopping the turn, increase the Counter Rudder Gain (Code 3)

You should be able to home in on the proper gain settings in a few minutes.

- a) If you find that high-speed performance gets "twitchy" when low speed performance is adjusted well, reduce the speed schedule (code 35) with the down arrow button and retune.
- b) If you find that high-speed performance gets "loose" when low speed performance is adjusted well, increase the speed schedule (code 35) with the up arrow button and re-tune.

You now want to try different speeds and make minor adjustments to the gains. You will probably need to readjust several times at different speeds to get the system working well at all speeds. If you find that it just won't tune for all speeds consider the following.

You must save and download any adjustments you have made to the Autopilot. To make the modified setup parameters into start up defaults:

Press and release the [Setup] button (the Setup LED Will light up) then
 Press and hold the [Select Load] GPS button (the load LED will light) and then
 While holding down the [Select Load] button, Press and release the **Deckmount** button quickly.
 Release the [Select Load] Button.
 (This will lock in your new settings)

Note: If the autopilot seems to be too active in rough water, adjust the Sea State Filter (code 1). Refer to page 31 for detailed instruction.

4. **Set North:** You must do this, if the autopilot is connected to the GPS.

To run a GPS course requires that the autopilot compass is in agreement with the GPS's course estimate. You need to set North with the pilot in standby mode. Do not set North except in calm sea's and un-accelerated conditions. You should be running at a reasonably high speed, it won't hurt to be running on plane with your main engine. With your GPS turned on and setup code 48 selected, press and hold the **GPS (Select Load)** button.

If the **Up Arrow** LED illuminates, this means that your GPS connection is not sending course information to the autopilot correctly. You must point your boat north and then press and release the **Deckmount** switch to set compass north.

If the **Up Arrow** LED does not illuminate, press and release the **Deckmount** switch to set compass north. In this case you do not need to be pointing north-you only need to be going in a straight line.

Your pilot will power down after north has been set.

Rudder and Counter Rudder Gain.

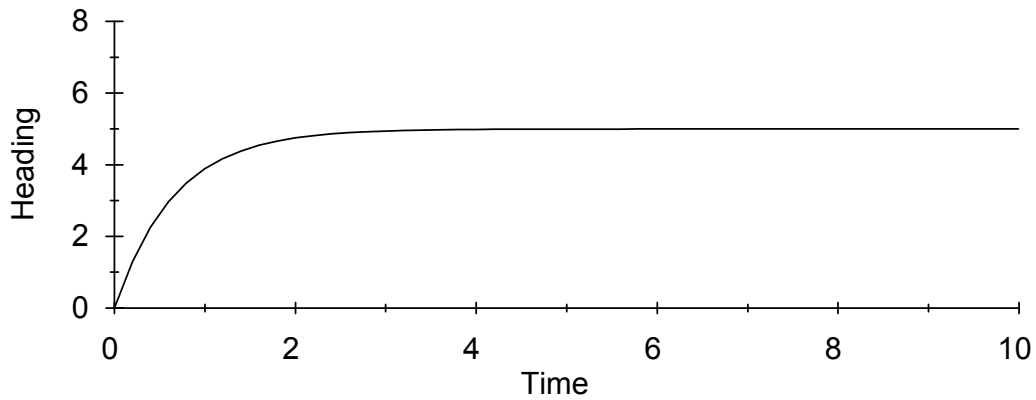
Let's assume that you pushed the Auto button when the boat was heading 45 degrees and that after a few seconds your boat has been turned, by wind, to a heading of 55 degrees. The autopilot (and you) know that you are trying to steer to 45 degrees and that your current heading is in error by ten degrees to the starboard. How much port rudder do you suspect is the right amount to steer to bring the boat back to 45 degrees in a reasonable time? Loaded question! The amount of rudder required depends on many variables like hull shape, boat loading, how fast the rudder can move, boat speed through the water, and more. If we had numerical values for all the variables affecting the required rudder deflection, we could calculate the required rudder gain and apply it with the rule: Rudder is applied in proportion to heading error and the proportional constant is rudder gain.

Since we can't make a very good guess at what value Rudder Gain should take, we have to adopt a cut and try approach to finding the proper value. Fortunately, we can provide some guidelines as to how the system behaves when the Rudder Gain is too large and when it is too small.

Counter rudder is rudder applied to oppose turning. It is used to "damp" heading changes and is more responsive to disturbances in heading than the proportional rudder deflections caused by heading error. Counter Rudder is applied in proportion to the rate of turn, as measured by the gyroscope, and the proportionality constant is Counter Rudder Gain. We can provide some guidelines as to how the system behaves when the Counter Rudder Gain is too large and when it is too small.

A good way to hunt for the proper Rudder and Counter Rudder Gains is by commanding the autopilot to change heading and watch the heading response. The following plot shows how a boat responds in heading when it is set up real well. At time = 0 the **Straight Right Arrow** button was rapidly pressed and released five times, the boat heading was initially 0 degrees, in a few seconds the boat heading is steady on 5 degrees. Tuning should be done with no more than a light breeze and ripples on the water. Tuning should be done in forward gear.

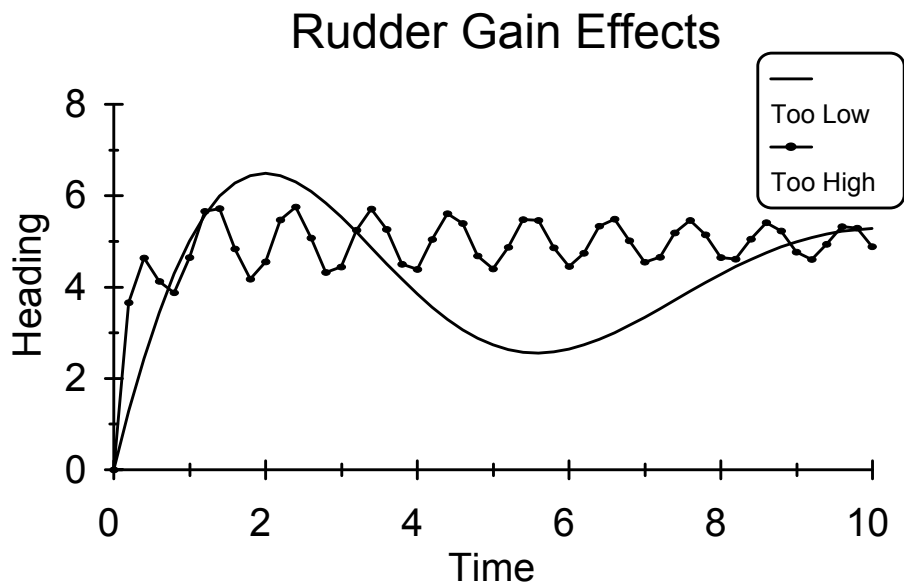
Well Tuned Response



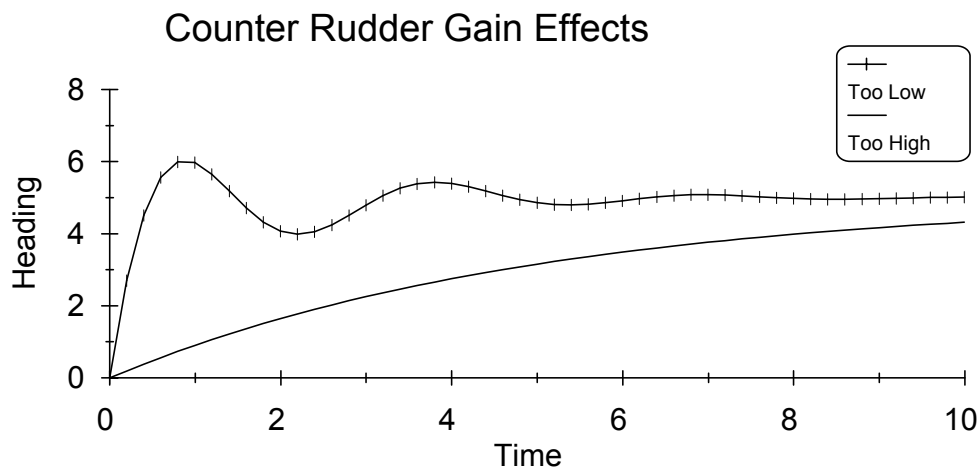
The objective of tuning is to set the gains so as to elicit a response with a shape like this that reaches the 5 degree heading in as short of a time interval as possible. You know that you have reached this tune when attempts to increase the Rudder Gain or Decrease the counter rudder gain results in oscillations in heading.

Initial factory setting for Counter Rudder Gain is on the high side for most boats and the initial factory setting for Rudder Gain is on the low side. So the normal search pattern is to increase Rudder gain and decrease Counter Rudder gain and look at the response after each change.

Continued.....



The Rudder Gain Effects plot shows that too low a Rudder Gain will make the heading response slow and sloppy, if the Rudder Gain is turned down much lower the heading response will become unstable (do everything but hold heading). The plot also shows, when the Rudder Gain is set too high, that the heading oscillates with a high frequency, the rudder will be seen to be oscillating with large amplitude and high frequency as the Rudder Gain becomes "too much."



Counter Rudder Gain effects are easy to see in the plot above.

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e-mail: autopilot.support@garmin.com

After you receive the RMA number, securely package the unit and ship it (insured) to the following address:

Garmin International, Inc.

1200 E. 151st Street

RMA number (insert your RMA number here)

Dock Door #1

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