# Care and Feeding of Autopilots

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Any device that simplifies matters for the vessel operator must itself be complex; so it is with autopilots.

In concept, the modern autopilot is pretty simple. A compass indicates the boat's actual heading, a control unit accepts the heading the operator wants, a microprocessor calculates the difference between the desired and actual headings, and a power unit acts on instructions from the control unit to move the rudder and turn the boat so as to eliminate that difference.

The devil is in the details. Each make and model uses different components and has different features. Nearly every modern autopilot—correctly sized, properly installed, and kept adjusted for current conditions—will reliably steer a vessel on a predetermined course; but autopilot problems are common. Some result from error at the purchase or installation stage, others are due to operator error or abuse.

In the highly competitive marine electronics market, some manufacturers engage in what one writer calls "specsmanship"—overrating their units to entice the buyer to purchase theirs rather than a competitor's. Under ideal conditions, i.e., a well-trimmed and balanced boat operating on a calm sea, a small pilot will steer a large vessel. But if you want your pilot to work well and long, size it for the worst conditions it will endure, not the best. Study the specs for models you are considering. Unless your boat fits in the middle of the size category for a particular model, opt for the next beefier one.

## Installation

Autopilot installation consists of two phases: mechanical placement of the components in the boat and adjustments once the parts are in place. Most owners hire a professional to install a new pilot, but it pays to check that person's work. Here are a few tips on autopilot installation.

**Compass:** Unless you can afford a very expensive gyrocompass, your autopilot will work on either a wet card or fluxgate compass, both of which respond to the earth's magnetic field. Naturally, they also respond to any other magnetic field in the boat, including the engine block and electrical circuitry. Also, they are greatly affected by motion, including rolling, pitching, and pounding. To minimize motion the compass must be mounted low in the boat, preferably at the waterline and slightly forward of amidships, close to the centerline. To prevent magnetic interference, it should be placed sufficiently distant from big masses of metal, circuitry, and electrical devices. Be sure the arrow on the cover is exactly parallel to the centerline and pointed forward, and never mount vertically except with an angle bracket which positions it on the horizontal plane.

After selecting a compass location but before bolting it down, move the compass horizontally in a circle of a foot radius around the chosen spot, and again vertically; deflection should be no more than five degrees. Once it is secured, test the compass again, and ensure that it reads correctly. Note the exact heading, then use a screwdriver placed next to the card to deflect it one way and then the other. After each deflection, it should return to within one degree of the original heading. You then may need to "compensate" the compass with adjustment screws and magnets, like your main navigation compass. Fluxgate compasses don't require the deflection test because they must be compensated internally after installation.

**Control Unit:** Follow the instructions. Put the thing where it is convenient when you want to use it, and not in the way the rest of the time. The trick with control units is selecting one that has the features you need. You can find lots of advertising and articles touting the features of each make and model.

**Power Unit:** On mechanical rotary (chain) drives, the size of the helm sprocket is critical, and the whole thing must be mounted where it is out of the weather and out of the way but still has correct angle and rigidity to impart full torque on the steering gear. If the salesman doesn't know exactly how to calculate sprocket size and other factors, get an engineer to help you work it out. Big problems result from improper sizing. On hydraulic units, you need to know the ram size on your steering gear to select the correct drive pump, but once you have it, installation should be pretty straightforward. If you have power hydraulic steering and need to use electric solenoid-actuated control valves, and you're not a hydraulic engineer, you'll probably have to hire a professional to do the job.

## Setup

Autopilots come in varying levels of sophistication. Take the old Wood Freeman Model 11 (they're still being manufactured), turn on the power, point the boat in the right direction, and engage the clutch. That's all there is to it. Take a more modern unit, like my 10-year-old Robertson, and you get 50 pages of instructions (half in Norwegian, to be sure, but still a lot of stuff to digest). On a modern unit you may have to set rudder limit (usually 25-40 degrees), rudder turn rate (around six degrees per second for a heavy displacement boat, up to 15 degrees on a planing boat), and off course alarm limit (typically 20 degrees). Usually there is a default setting for these factors but you may want to check and reset them.

In addition, you may have remote control units, portable remotes, jog sticks, a rudder angle indicator, and inputs from GPS or loran. (If GPS or loran is connected and the selector switched to that input, the pilot will disregard the compass and will steer toward a waypoint rather than on a course.) All these components may feed into a central junction box, which is normally mounted at a remote location, with circuitry to all the other parts. Installation and setup of some components is simple, while

others like the rudder feedback unit require careful planning and execution; but all circuitry is delicate. Again, read the instructions.

Most units have a set of controls with names like "sea state," "deadband," "yaw," and "rudder." They all pertain to the way the control unit orders the rudder to respond to the difference between desired and actual courses. Rudder, or rudder gain, controls the amount of rudder movement the control unit orders in response to a given amount of heading error. In rougher sea conditions where the boat tends to swing off its desired course by a wider margin, rudder gain can be increased to provide more immediate response; in calm conditions, gain is reduced to smooth and moderate the response.

Deadband or yaw (also known as sea state) is a control that limits the unit's response to yawing or swinging from side to side, as in a following sea. Since the pilot can't eliminate yawing under some conditions, this control makes the unit ignore repetitive minor error to save energy and wear on the steering gear and prevent overcorrections. Increasing deadband allows the boat to undergo normal yaw while still putting it back on course if it deviates more than a predetermined number of degrees. Reducing deadband keeps the boat from making S-curves in calm weather.

Modern high-end units have learning logic in their operating software that enables them to "learn" characteristics of the individual boat, allowing them to adjust output to the drive unit to achieve optimum steering performance. This sophisticated software is one of the factors that make top units so expensive.

### Maintenance and Troubleshooting

Like all electronics, autopilots must be kept clean and dry and fed adequate, steady current. The junction box, if it has one, is particularly vulnerable to moisture corrosion because there are small metal contacts in an unsealed box. If you live in a cold, damp climate, it's a good idea to spray the inside of the junction box with a corrosion preventive or, better yet, make a wiring diagram, disconnect the wires, and take the box and control head home with you.

Most control units are not intended for owner repair, although some makes actually come with instructions for replacing the main circuit board. Some have self-diagnostic programs installed with their operating software which provide coded clues to faults.

If your autopilot simply doesn't work, the obvious thing to check first is the power supply. Use a volt-ohm-meter to check for power at the junction box and control unit. There may be a breaker in the system, or the junction box may have a fuse. But sure to determine before heading out whether the system has a hidden fuse, and get spares. You may need a particular little 2-amp fuse you wouldn't ordinarily carry in your spares kit.

Conventional wisdom now holds that once electronics are turned on, they should be left on for the season. Sure enough, my experience is that autopilot failures most often occur at the moment the unit is turned on.

Poor steering can result from improper adjustment of rudder gain or rudder speed, or problems with the compass. If the thing tries to steer but veers off wildly in unintended directions, check the rudder feedback system. Some models have a little plastic ball joint connecting the linkage, and if this comes loose, the whole pilot goes haywire. Also, the feedback potentiometer at the rudder stock can go bad and may need to be replaced. Momentary veering can result from electrical surges within the boat, such as keying the mike on an HF radio, or from passing through areas of magnetic anomaly.

If the above tips don't solve your problem, you probably have to send the control unit in for repair.

A final safety tip: some models are susceptible to "runaway" and can't be turned off, and some, if damaged (as by a wave coming through the pilothouse), will lock the steering to one side. Locate or install a breaker which allows you to disable the pilot, and a solenoid, valve, or piece of linkage which lets you disconnect the drive unit from your steering system if need be so that you can regain control of your vessel. ✦