

The Magic of GPSS

by Kevin Crozier

As a CFI and BPPP instructor one of the most common problems I see with pilots is a lack of understanding about their autopilot (AP) and specifically GPSS, also known as GPS Steering or, now more commonly, Roll Steering. In-depth knowledge and complete understanding of your autopilot can save your life. But if you aren't careful that same autopilot can kill you. Unfortunately, the autopilot doesn't necessarily do what you *want* it to do, it does what you *tell* it to do. Good training and practice is a must to safely and efficiently operate this key workload reducing tool in your aircraft.

There are many autopilot makes and models in our Beechcraft airplanes, so this article will provide general guidance on autopilot operation but will not describe the exact operation of any particular autopilot. It is your responsibility as the PIC to review the POH and Pilot Guides for your autopilot and avionics to understand the operation, capabilities and limitations of your specific system.

I will quickly review the basic components of autopilots and modes of operation. Finally, I'll discuss how GPSS/Roll Steering works and how to use it in various phases of flight.

Autopilot components

All autopilots have the same basic components: an orientation source, servos, controls, and flight computer. For legacy APs, the orientation source is one of the gyroscopic instruments. There are two basic type of autopilots: attitude-based autopilots (most Bendix King and Century units) that use the attitude indicator as this source, and rate-based autopilots (STEC) that use the turn coordinator.

The servos are small electric motors connected to the control cables and actually move control surfaces. An AP can

have just one servo (roll, a "wing lever") or up to four servos (roll, pitch, pitch trim, yaw). Next, is the component which the pilot interacts with the most: the controller, which consists of the control head (which may be attached to the flight computer) and the various buttons (go-around, trim, CWS, disconnect, etc.) used to interact with the AP. Finally, the most important component in the AP is the flight computer. The flight computer can be located in the instrument panel or in the avionics bay, and connects all of the system components together. The computer listens to the selected navigation source, current heading, heading bug, and attitude source to drive the servos and control the aircraft.

Autopilot operation

Engaging the autopilot is typically very straightforward and usually involves just pressing the desired mode button. On the other hand, do you know every possible way to disconnect your AP? There likely four or more different means to disconnect the AP, including pressing the big red AP disconnect button, pressing the trim switch, turning off the avionics master, and even pulling the AP and/or trim circuit breakers. I recommend placing

plastic marker rings around those breakers for quick identification in a potentially stressful situation.

We do this because when "Uncle Otto" decides to go a different direction than you intended, you need to be able to disconnect the AP very quickly without consulting a checklist. Take the time now to review your AP supplement and practice all the ways to disconnect the AP. It could save your life!

Make sure you run the specified POH preflight checks as well. It is important to verify the operation of the disconnect button and the trim switches so you don't end up being surprised if they aren't working correctly.

Autopilot modes

AP operating modes are divided into two types: Vertical Navigation modes, used to change and hold altitude; and Lateral Navigation modes, which deal with the aircraft's path over the ground. We will discuss the most common and frequently used modes, but don't worry if some of these modes don't look familiar. Not all APs have every mode.

Vertical Navigation

Pitch Attitude Hold mode

Holding a constant pitch angle is the default vertical mode when engaging many autopilots. At the time of engagement, the AP will hold the current pitch angle shown on the attitude indicator. Some APs have Control Wheel Steering (CWS) switches that can be used to adjust the pitch angle. Most systems revert to pitch mode when altitude hold or vertical speed modes are canceled. Pitch mode is generally a safe option for climbing because it's unlikely to

(continued on page 26)

cause a stall. It is also used frequently for climbs and descents with APs that don't support vertical speed modes.

Altitude Hold

Altitude Hold Mode is usually engaged by pressing a button that says ALT. In this mode the airplane will maintain the aircraft's pressure altitude at the time the switch is pressed. The AP will typically overshoot the engaged altitude by 50 to 100 feet and eventually settle back to

the desired altitude. APs that support glideslope tracking will automatically disengage ALT mode when the glideslope (GS) couples in approach (APPR) mode.

Vertical Speed / Altitude Preselect

In this mode, the AP can climb or descend at a selected vertical speed and then automatically level off at a pre-selected altitude. Caution must be used for climbs to higher altitudes, as legacy autopilots are not airspeed aware and can

stall the airplane if it is not able to maintain the selected vertical speed.

Lateral Navigation

Roll mode

When you engage many autopilots before providing lateral direction guidance, it will default to roll mode. In the simplest form, roll mode simply holds the wings level. But in some systems, roll mode can also hold a constant bank angle. Most APs don't have a specific button for roll mode, and there are some systems that don't have roll mode at all.

Heading mode

Heading mode is usually engaged by pressing a HDG button on the controller. In this mode the aircraft will automatically turn and hold the heading indicated by the heading bug. When the heading bug is turned to a new heading, the aircraft will follow the bug and turn to the newly selected heading. It is smart to always "sync" the bug to your current heading before engaging HDG mode to avoid a surprise turn (that may have you headed for terrain). Heading mode can also be used to set up an intercept to the flight plan course. It will then automatically disengage when the AP couples in the navigation (NAV) or approach (APPR) mode.

NAV mode / Approach mode

In Navigation and Approach modes the autopilot is following the deviation indicator (the needle) of the selected navigation source from a VOR, LOC/ILS or GPS course. While these modes have served us well for many years they also have some issues because the AP is not aware of wind correction angles or the aircraft's ground speed. In these modes, the AP's focus is to keep the CDI needle centered, which can lead to S-turns across the selected course. In addition, these modes are not able to fly complex flight plan segments like procedure turns or holds. When APPR mode is selected the autopilot gains are increased, so the AP will be more aggressive when making course corrections to center the needle. For APs that support glideslope tracking, the APPR mode must be active and the

(continued on page 28)



Treat your Beechcraft the way it deserves.

For the past 20 years, we have gone the extra mile in service and quality control to make owners happy and proud of their aircraft. Come see David at Beaver Air Services in Houston. KDWH

BEAVER
AIR SERVICES
www.beaverairservices.com

713-851-8960
beaverair@swbell.net

BEECH PARTS – ALL MODELS

Musketeer/Sport/Sundowner/Sierra/Skipper/Bonanza/Debonair/T34/TravelAir Baron/Duchess/Duke/TwinBonanza/QueenAir/KingAir/99 & 1900/Airliner

One of the largest "all-Beech" inventories in the world

Structural, Landing Gear, Flight Control, Accessories, Instruments, Kits, Hardware, Interior Parts, Etc. Since 1969, your best source for affordable genuine replacement parts; call the Beech Specialists...



ARRELL AIRCRAFT SALES, INC.
SPECIALIZING IN BEECHCRAFT PARTS
701 Del Norte Blvd., Unit 220
Oxnard, California 93030
(805) 604-0439/FAX (805) 604-0429
www.arrellaircraft.com
e-mail: BeechedOut@aol.com
(Minutes from Camarillo & Oxnard Airport)



Aviation Design

Quality Aircraft Interiors

THALLOCK@AVIATIONDESIGN.COM

AVIATIONDESIGN.COM

Pine Mountain Lake Airport (E45)
Groveland CA. 95321
(800) 725-4297

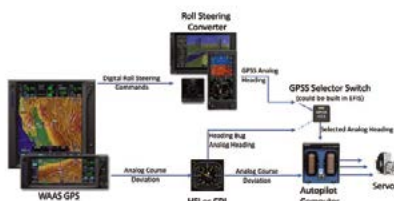


aircraft must be below the glideslope for the AP to capture and track the glideslope.

GPSS (aka Roll Steering)

Finally, this brings us to roll steering, also known as GPSS (GPS Steering). Roll steering is typically an add-on to legacy autopilots that allows them to use data provided from a WAAS GPS navigator to precisely fly complex flight plans, approaches, procedure turns and even holding patterns. Early roll steering converters were developed by DAC and Icarus and consisted of a switch and a small box that connected to your GPS navigator. Today, most retrofit EFISs including Aspen PFDs, Garmin G5s (HSI mode), and Garmin G500s/G600s have roll steering converters and the selector switch built-in to the unit.

Roll steering converters drive the autopilot by receiving commands from the GPS navigator and converting that information to a heading signal. Your WAAS GPS is able to provide very precise guidance



commands to the autopilot as it is aware of your track over the ground, ground speed, and the desired track to the selected waypoint. Using these commands, the roll steering converter guides the aircraft by electrically “turning” the heading bug to the necessary heading to stay on the flight planned course. This is the reason why, when using GPSS on legacy autopilots, the AP must be heading mode and *not* in NAV or APPR. The diagram shows how a retrofit GPSS interfaces with a legacy autopilot.

Now that you understand how GPSS works, we will discuss how and when to use GPSS roll steering.

Enroute

Once you have a roll steering converter installed, for enroute GPS based navigation you should *always* use GPSS. There is no reason to use NAV mode once you have GPSS installed. GPSS guidance is much more precise and completely eliminates S-turns as the aircraft proceeds from waypoint to waypoint. The AP will be able to make sharp turns and even turn anticipation without your assistance.

Summary: For GPS enroute navigation your AP should be in HDG mode and GPSS should be enabled.

What about approaches?

This is where it gets a little tricky. It is important to understand the differences between HDG/GPSS and APPR modes.

Non-Precision VOR, NDB and GPS approaches (without glideslope)

For approaches without a glideslope, you should use GPSS for the entire approach. Make sure that you are monitoring the primary nav aid (VOR/NDB) when flying a GPS overlay approach. You can do this because the GPS keeps sending roll steering commands as long as the GPS navigator has a valid flight plan. It doesn't matter what mode (GPS or LOC/VOR) is selected on the navigator. You must manage the vertical portion of the approach with the AP pitch control and the ALT hold modes. As discussed above, the AP will continue to descend past the altitude when you press the ALT button. To avoid undershoot, press the ALT button about 50 feet prior to MDA or step-down altitude (don't forget to increase power as well). Once the aircraft is actually at the correct altitude you can either toggle the ALT or press the CWS button to capture the correct altitude.

Summary: For non-precision approaches, use HDG/GPSS to track the approach, with pitch hold and ALT modes to manage the vertical profile.

GPS LPV, ILS and GPS approaches (with glideslope)

For approaches with a glideslope, autopilot operation is slightly more

Autopilots of Tomorrow - Available Today!

Providing you with complete peace of mind, Butler Avionics has cost-effective options to give you the best co-pilot you have ever flown with.

280 Gardner Drive, Suite 3 / New Century, KS 66031-1104
 FAA CRS# TF2R185L / Phone: 913-829-4606 / www.butleravionics.com

The Beechcraft Baron and Bonanza specialist

Over 30 years of providing quality maintenance

Engine & Airframe upgrades
Pre-Purchase 100 Hour & Annual inspections

soaero@att.net • soaero.com
 770-229-2563 • 73 Cedar Ridge Airport Road, Griffin, GA 30223

Located at Cedar Ridge Airport (GA62), 25 miles South of Atlanta

complex with GPSS. You will begin the approach in HDG/GPSS mode to fly the airplane through the initial approach segments, procedure turns or holding pattern course reversals. Once through these initial legs and inbound to the FAF the GPSS will precisely align the aircraft on the final approach course. Once stable on the final approach course, watch for the GS needles. When they begin to descend it is time to select the APPR mode. We do this because the AP *must* be in APPR mode to capture the glideslope. If your AP doesn't support glideslope tracking, then fly as described for a non-precision and use the pitch hold mode to track the glideslope.


Summary: For a precision approach, use HDG/GPSS mode until established on the final approach course and below the glideslope. Then, switch to APPR mode for GS capture and final approach course tracking.

Missed Approach

GPSS roll steering can also be very helpful during a missed approach. Because it can fly complex flight paths, the AP can significantly reduce your workload during this very busy phase of flight. If you used GPSS on a non-precision approach, then the GPSS is likely already helping fly the miss because HDG/GPSS mode is already enabled. When missing out of a precision approach you must return to HDG/GPSS mode once you are cleaned up and climbing.

Summary: On the missed approach and once the airplane cleaned up and climbing, select HDG/GPSS with pitch hold mode.

Training

An IPC or flight review is a great time to review your autopilot usage. Prior to the flight you should review autopilot manuals, GPSS/EFIS manuals and POH supplements so you completely understand the capabilities of your autopilot and how your specific system is configured. Then work with your BPPP instructor or CFI to put together a custom flight plan that will allow you to use all of the modes of your autopilot system. Autopilots and GPSS are an amazing workload reducing tools, especially during IFR approaches, but you must understand how they work to use them correctly. Fly Safe! 

Kevin Crozier is the caretaker of a 1981 A36, a BPPP CFI and software DER. He is the owner of Ktronics Aero Services located near Austin, Texas.

BRAKE MASTER CYLINDER SEAL UPGRADE & REPAIR KIT

Available for Baron & Bonanza Aircraft



Improve Your Aircraft While Reducing Your Maintenance Costs.

Nobody pays much attention to the piston rod seal in their brake master cylinder until it starts leaking. Even when it does leak, it won't cause much more than carpet damage unless you ignore it. Whether your brake master cylinder requires repair due to leakage or you want to take a proactive approach, the Marsh Brothers' Brake Master Cylinder upgrade/repair kit is the solution that will fix it once and for all.

Eliminate the risks associated with typical failure modes of traditional O-rings in dynamic seal applications today.

- Provides the ability to rebuild your brake master cylinder. No need to purchase a replacement cylinder.
- Transport Canada and FAA Approved
- Easy to Install (Tooling included)
- Long Lasting



BELIEVE IN A BETTER WAY! 1.800.263.6242 | info@MarshBrothersAviation.com | www.MarshBrothersAviation.com