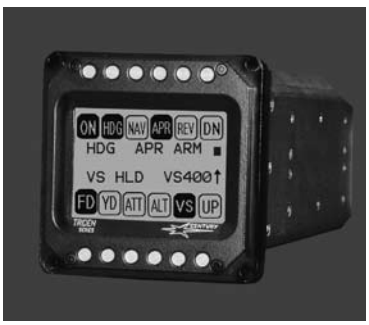
Retrofit Autopilot Systems
Buyer's Guide

BY PAUL NOVACEK

Autopilots come in many different forms, but they all perform the same task, which is to relieve the pilot from the sometimes-mundane task of flying the aircraft. They accomplish this in a few different ways, but all use the three basic building blocks of an autopilot: sensing position, computing desired goal and driving flight controls to achieve the goal.



Century Flight Systems' newest autopilot line, the Triden series.

A Little History

It all began with an invention developed by Elmer Sperry in the early 1900s — the gyroscope. This device uses a spinning mass that keeps its orientation while an airplane moves around it, which is the basic principle underlying today's artificial horizon gyro.

Originally designed to help ships steer a steady course, Elmer's son, Lawrence Sperry, used his father's invention to successfully launch an aircraft company specializing in aircraft control systems. Along the way, the Lawrence Sperry Aircraft Co. built the Messenger airplane and gyro-based instruments that are still in use today. Sperry began experiments in the early 1920s using gyros to sense attitude and using motors to drive the controls, resulting in the precursor of the modern-day autopilot.

During the 1930s and 1940s, the Sperry autopilot was further developed for use in airliners and as an integral part of precision bombsights. The famous Norden bombsight of World War II used precision optics, a mechanical computer and autopilot technology to stabilize the heavy bomber during a bomb run. During the run, the bombardier controlled the aircraft through use of the autopilot.

Continuing work by the Sperry Corp. during and after the war, as well as Minneapolis–Honeywell and other manufacturers, further refined the autopilot, making the components lighter, smaller and more capable. Over the years, advances in electronics technology made it possible for autopilots to land an airplane under zero-visibility conditions. In 1964, Smiths Industries developed an autoland system for airliners, enabling landings in conditions far below previous minimums.

Eventually, the autopilot evolved into the modern flight management system using fly-by-wire techniques to control the aircraft from takeoff through landing.

Basic Autopilot Functions

An autopilot's primary function is to provide stability in one or more axes. Let's use the pitch axis to illustrate this stability function. As an aircraft encounters turbulence, the attitude indicator sends a signal to the autopilot computer indicating the nose has pitched up. The computer processes this signal and sends a signal to the pitch servo instructing it to apply down elevator, thus bringing the aircraft back to level pitch. This stabiliz-

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AUTOPILOT COMPARISONS

Manufacturer	Model	Description	List Price
S-TEC	20	Roll axis with nav tracking, contained within turn-coordinator	$6,400 – 8,860
	30	Roll functions with altitude hold, trim prompting, contained within turn-coordinator	$10,180 – 13,980
	30 Alt	Stand-alone altitude hold, trim prompting	$5,440
	40	Roll axis, 3” panel mount	$6,500 – 9,000
	50	Roll functions with altitude hold, trim prompting, 3” panel mount	$10,300 – 15,300
	55X	Full-featured, radio stack mount	$17,360 – 28,980
	60-1	Roll channel, full-featured, 3” panel mount	$7,900
	60-2	Full-featured, 3” panel mount	$14,000
	60 PSS	Stand-alone pitch, full-featured	$8,200
	65	Full-featured, pedestal mount	$24,920 – 31,760
	Yaw Damper	Stand-alone or integral	$5,200 – 6,360
	MAGIC 2100	Integral part of MAGIC DFCS	Included in EFIS package
Honeywell	KFC-225	Full-featured for piston singles and twins, radio stack mount	$38,000 – 60,000
	KFC-325	Full-featured, EFIS compatible for turboprop, pedestal mount, RVSM compliant	Included in EFIS at $310,000 (typical)
Century	I	Roll axis with nav tracking, contained within turn-coordinator	$6,750
	41	Full-featured, pedestal mount	$24,495
	2000	Full-featured, radio stack mount	$8,995 – 19,995
	Triden	Full-featured, 3” panel mount	$12,995 – 22,995
Chelton	AP-3C	Full-featured, radio stack mount, single- and multi-engine piston	$14,650 – 16,150
TruTrak	DigiTrak	Roll channel, solid-state DG, GPS tracking	$1,695 (2”), $1,745 (3”)
	Pictorial Pilot	DigiTrack within turn coordinator	$2,095 (2”), $2,145 (3”)
	DigiFlight II	Panel mount (2”), GPS tracking with altitude hold	$3,850
	DigiFlight II G	Panel mount (2”), GPS steering with altitude hold	$4,225
	DigiFlight II VS	Panel mount (2”), GPS tracking with altitude hold, vertical speed and trim prompting	$4,350
	DigiFlight II VSG	Panel mount (2”), GPS steering with altitude hold, vertical speed and trim prompting	$4,725
	DigiFlight II VSGV	Panel mount (2”), GPS steering with altitude hold, vertical speed, trim prompting and GPS VNAV	$5,225
	DFC-200 ATI/AS	Panel (3”) or radio stack mount, full featured	$6,900
	Sorcerer AS	Radio stack mount, full-featured, GPS vertical mode, altitude preselect, airspeed select	$9,500
	AITrak / VS	Stand-alone altitude hold, vertical speed select with VS model	$1,695 – 1,995
	ADI Pilot I	Roll autopilot with ADI, GPS tracking, digital DG	$2,795
	ADI Pilot II	Roll & Pitch autopilot with ADI, Alt hold, GPS tracking, digital DG	$3,995

Note: The ranges of list prices reflect the different prices for installation kits and optional features.

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ing process repeats itself many times per second and keeps the aircraft balanced around a fixed attitude.

Once basic stability has been achieved around a set point — in the steady state case, level attitude — the pilot can change the set point. This process is called homeostasis, in which stability is achieved around a preset, but resetable point. This homeostasis process works for all the basic autopilot functions, such as heading and altitude hold.

An autopilot works in much the same way as does your body. Your body uses three interrelated systems to accomplish a task, even as simple a task as taking a drink of water. Your eyes see where the glass is on the table, then your brain processes the position of the glass and determines what muscles are needed to lift the glass. An important part of this process is the open-loop feedback that senses your movements and corrects for any necessary adjustments.

While lifting the glass to take a drink, your eyes observe the image of your arm raising the glass. This image is sent to your brain, where it is perceived that your arm is not going in the right direction. A corrective signal is sent to your muscles instructing them to move in the proper direction. The process, called feedback, then starts all over again, allowing the system to constantly sense and correct the actions until the task is completed.

As does your body, a gyro serves as the autopilot's eyes, or sensors, sensing the current position of the aircraft in relation to the surface of the earth. The current position is sent to the autopilot computer, which performs all necessary calculations, then sends a signal to a motor that moves the aircraft control surface. The aerodynamics of the aircraft respond to the control movement and provide feedback to the gyro, which begins the process again.

Depending on the model and capabilities of the particular autopilot, either an artificial horizon or turn coordinator gyro is used as the primary sensor. Additional sensors also are used, such as an air pressure sensor, to determine altitude, and accelerometers to detect motion. The computer performs all the computations necessary to control the aircraft. The computer output is sent to a servo providing the "muscle" for each control axis.

Meggitt/S-TEC

The Meggitt/S-TEC family of autopilots comprise the basic of wing-levelers to fully integrated flight control systems. For simple roll control, the System 20 is fully contained in the turn coordinator and roll servo. The upper end of the S-TEC line, the MAGIC 2100, is an integral part of its Meggitt EFIS system as installed in the Piper Meridian and as retrofit into turboprop aircraft.

All S-TEC autopilot systems use hardware, servos and sensors common throughout the product line. This commonality gives the aircraft owner significant advantages in serviceability, reliability and overall cost. It's also the foundation of the S-TEC upgrade/trade-in program, which gives an autopilot buyer the option of buying a system today and upgrading it to a system with more features and functions later. An owner can purchase a System 20 for just the roll axis, then later upgrade using the same servo and mounts, thus saving hours of installation time.

For the kit-built market, S-TEC has a program designed to specifically meet the special needs of custom installations. The company has specific kits available for the more popular kit airplanes, such as Lancairs, Glasairs and others. If S-TEC doesn't have an "approved" kit for a specific kit airplane, the company will work with avionics shops on a custom installation or possibly develop a kit for that specific airplane.

S-TEC's newest autopilot is borne from the marriage to Meggitt. The MAGIC 2100 digital flight control system is an integral component of the Meggitt MAGIC line of control and display units and is not sold as a stand-alone system; however, plans are in the works to provide stand-alone capability in the future.

The MAGIC 2100 DFCS is a digital attitude based flight control system in an avionics stack-mounted case containing the mode selector/programmer, annunciator, roll, pitch and yaw computers, including the servo

The entire line of Meggitt/S-TEC autopilots, from simple wing-levelers to full-function flight control systems.

The Honeywell-Bendix/King KFC-225, a full-featured flight control system.

amplifiers. The system also provides integrated altitude selector and alerter modes.

S-TEC is preparing to launch two new digital autopilots for OEM and retrofit applications. The first new product will be an embedded flight control system for the twin-turboprop and the light jet market with all the features of a full corporate jet automatic flight control system, including autothrottle.

The second initiative is the top-to-bottom reinvention of the company's autopilot line, with the goal of providing additional features, such as WAAS approaches. Concept development of the new autopilots is under way, and the plan is to go from analog to fully digital architecture.

For more information, contact Meggitt/S-TEC at 800-872-7832 or visit www.S-TEC.com.

Honeywell – Bendix/King

The Bendix/King division of Honeywell has two lines of autopilots, the Honeywell line for the turboprop and corporate jet aircraft, and the Bendix/King line for general aviation aircraft. Honeywell absorbed the autopilot pioneers, Sperry, to become one of the leading autopilot manufacturers since that first autopilot designed by Lawrence Sperry.

Honeywell's turboprop, jet and airline autopilots currently are integrated into complete flight management systems and are not sold as retrofit autopilots, but its Bendix/King line of autopilots are available for installations in most of the general aviation fleet.

The KAP-140 system is installed mainly as original equipment in the Cessna single-engine line of aircraft, but also is available for retrofit into select single-engine airplanes. The simple, yet fully featured KAP-140 uses the turn coordinator as its primary sensor and includes three models: roll channel only, roll and pitch channels, and the fully functional system that includes altitude preselect.

The bigger brother of the KAP-140, the KFC-225 is an integrated, all-digital flight control system that combines the functions and features of three separate avionics units: an autopilot computer, altitude pre-select/alerter, and optional yaw damper. The KFC-225's simplicity of design and ease-of-use gives pilots the ability to efficiently and effectively manage workload. For enhanced precision and performance, the system's advanced algorithms utilize digital interfaces with GPS and EFIS.

The KFC 325 is a three-axis digital flight control system that can be installed with either the conventional electromechanical flight instruments or electronic flight instrument systems (EFIS).

For more information, contact Honeywell – Bendix/King at 877-712-2386 or visit www3.bendixking.com.

Century Flight Systems

Century Flight Systems, based in Mineral Wells, Texas, began manufacturing autopilots in the early 1950s. Don Mitchell first installed an autopilot in a Bonanza under the trade name AirBoy. Ever the innovator, the company grew and became EDO Aire Mitchell in the mid-1960s, and has since installed autopilots in just about every general aviation airplane.

The company became Century Flight Systems in 1983, and its prolific coverage of the entire autopilot spectrum is apparent with its current offerings. As a basic roll-channel autopilot, the company still markets the Century I, which is wholly contained in a turn coordinator and roll servo.

The line culminates in the newly developed digital Triden line of autopilots. All of its newer autopilots use the building block modular approach to installations in which capabilities are added by just adding components.

The company currently offers the Century I, 41, 2000 and Triden. The Century 41 is an older, but reliable autopilot for upper-end piston twins and turboprops. The system comprises a remote-mount computer system with mode selector and annunciator available with gyros or interface units to allow the use of the existing gyros.

The Century 2000 is an affordable advanced position and rate-based flight control system available in one, two or three axis configurations. The system is expandable, so features can be added to meet changing needs without replacing the entire autopilot. Standard features include advanced digital circuitry, GPS/VOR/LOC/BC intercept and tracking, glideslope capture and altitude hold. Optional features include automatic/manual electric trim, flight director, HSI or digital

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altitude preselect.

Century Flight Systems' newly developed Triden series of flight control systems uses advanced digital circuitry to process position and rate data to produce comfortable flight dynamics in rough or smooth air.

The Triden's list of standard features includes GPS/VOR/LOC/LOC REV coupling, glideslope coupling, selected angle intercept when using an HSI (45 degree intercepts using a DG), altitude hold, voice prompter, attitude hold, vertical speed select, trim prompting and a crisp backlit LCD screen. The expandable architecture of the Triden series allows for easy upgrades, autotrim (manual electric trim), digital altitude pre-select, single-cue V-bar flight director and dual-sensing yaw damper (based on aircraft approval).

For more information, contact Century Flight Systems at 940-325-2517 or visit www.CenturyFlight.com.

Chelton

Chelton Aviation, based in Denton, Texas, is a subsidiary of the large Chelton Group of companies. Chelton Aviation develops the AP-3C, a digital autopilot.

The design originated in Bologna, Italy, as the AP-1 autopilot system in 1973, and was designed by Professor Giuseppe Basile when he was teaching electronics and control automation at the University of Bologna.

In 1982, the AP-2B and AP-3B received FAA TSO certification for sale and use in U.S. aircraft. In July 2001, Chelton Avionics purchased the product and over the next year redesigned the controller unit to use the latest in electronics technology.

The full-featured AP-3C autopilot from Chelton Aviation.

The autopilot is suitable for both single- and multi-engine airplanes, and does not require external adapters or altitude sensors. The pitch channel drives the pitch trim system and no elevator servo is required. Both pitch and roll channels are AHRS stabilized, but the system also is capable of interfacing with existing autopilot gyros and navigation signals. The computer/controller can be mounted in the 6-inch avionics stack or pedestal.

The AP-3C is a full-featured autopilot with ILS tracking, GPS steering (lateral and vertical), automatic pitch trim, altitude preselect, vertical speed select and pitch/roll angle hold. The Chelton autopilot is certified in many of the more popular Beech, Cessna, Piper, Mooney, Lancair and Grumman American aircraft. The AP-3C system is compatible with any airplane platform given the proper and appropriate control mechanical interface.

Three major components make up the AP-3C system: the controller unit, roll servo and pitch trim servo. The autopilot is unique in the small aircraft industry because of its ability to fly the aircraft in the vertical channel using only a pitch trim servo without an elevator servo. The concept of flying the elevator surface using the pitch trim control has long been employed in large aircraft and now is available to the small aircraft market.

This method of flying the aircraft provides for a safer and more turbulence-stable aircraft. This method also provides the characteristics of the aircraft always being in proper pitch trim during autopilot operation and disengagement.

For more information, contact Chelton Aviation at 940-320-3330 or visit www.CheltonAviation.com.

TruTrak

TruTrak is a newcomer to the autopilot scene and currently is marketing only to the kit-built and experimental crowd. Based in Springdale, Ark., the company provides a multitude of autopilot and instrument choices for the kit builder at competitive prices.

TruTrak even supplied the autopilot for the Virgin Atlantic Global Flyer — a much-relied-on system for pilot Steve Fossett on his solo trips around the world.

TruTrak has delivered more than 3,000 autopilot systems and currently offers four product

The line of TruTrak autopilots designed and priced specially for the kit-built and experimental aircraft market.

lines, from the basic DigiTrak single-axis system to the sophisticated and full-featured Sorcerer AS. The simple DigiTrak computer/controller is available in both 2-inch and 3-inch instrument mountings. It only needs an external roll servo and a few switches to complete the installation.

For less than $2,000, it provides a GPS-slaved solid-state DG, GPS nav tracking, heading tracking, magnetic backup mode and control wheel steering.

All TruTrak autopilots use a built-in magnetic sensor calibrated upon installation, thus providing heading information without the need for a remote-mounted flux sensor. The DigiTrak also is available married to a turn coordinator called the Pictorial Pilot, available in 2-inch and 3-inch versions. Increased capability is gained by adding a pitch channel with the DigiFlight II. The 2-inch computer/controller employs a more complete display, altitude hold and GPS steering. Some models of the DigiFlight II use a trim-sensing pitch servo to annunciate out-of-trim conditions and control vertical speed.

For even more capability, including ILS tracking, the DFC-200 is a full-featured autopilot available in either 3-inch or radio-stack computer/controller. The newly released Sorcerer AS combines all the functions of the DFC-200 and includes GPS VNAV, digital altimeter, reverse LOC, selected-angle intercept and an altitude alerter.

Servos, mounting brackets and linkages for any of the TruTrak systems can be purchased and installed as required during the construction of a new aircraft. For the more popular kit-built or experimental aircraft, TruTrak has servo installation kits that include aircraft specific mounting brackets and push rods at no additional cost.

To accommodate variations in aircraft requirements, TruTrak provides a choice of three different torque capability servos, which are mechanically interchangeable. The maximum torque capability of the servo is electronically set to the lowest value that allows the autopilot adequate control authority so the pilot can override the autopilot with the least possible effort.

The high-torque servo is a new design that allows the TruTrak autopilots to fly much larger aircraft than possible with the standard servos. For example, the Lancair IV Turbine, L-39 and Virgin Atlantic Global Flyer all are flown using the high-torque servo.

Accessories to the autopilots include a newly released attitude direction indicator (ADI), which uses solid-state gyro sensors (mechanical display) and many innovative warning annunciators that indicate extreme bank and pitch angles. TruTrak also offers stand-alone 2-inch and 3-inch turn coordinators and a stand-alone altitude hold computer with servo.

For more information, contact TruTrak at 479-751-0250 or visit www.TruTrakFlightSystems.com.

Collins/Honeywell

Both Collins and Honeywell Business & Commercial manufacture autopilots, but they do not offer the autopilots as stand-alone systems. The integration of autopilots into flight management systems requires these autopilots be sold within complete retrofit packages that include FMS, EFIS and CNI installations. ■