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The Aviation Consumer®

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The Aviation Consumer

EDITOR
Larry Anglisano

SENIOR EDITOR
Rick Durden

CONTRIBUTING EDITOR
Phil Lightstone

EDITOR AT LARGE
Paul Bertorelli

SUBSCRIPTION DEPARTMENT
P.O. Box 8535
Big Sandy, TX 75755-8535
800-829-9081
www.aviationconsumer.com/cs

FOR CANADA
Subscription Services
Box 7820 STN Main
London, ON 5W1
Canada

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AIRVENTURE INNOVATORS

These are often first-time vendors invited to set up shop in the AirVenture Innovations Showcase building at Oshkosh. I like spending time there because it's a good place to shoot. The lighting is good, it's relatively cool and it's the launching ground for products that are a little different than the ones around Boeing Plaza. Some make only one appearance at the show, but others have enough momentum to come back for more. That was the case with Opener Aero, which was the attention getter last year with its BlackFly ultralight.

The epitome of maturing electric tech, the VTOL ultralight is carbon-fiber and powered by eight electric motors—each weighing four pounds, making 130 pounds of thrust. This thing isn't vaporware. Opener has been testing motor-rotor sets for more than four years, covering a distance equivalent to 20 circumnavigations of the globe during flight testing. With a 25 percent reserve, the VTOL can fly for about 25 miles before a recharge. With a regular 110-volt outlet, it can charge in seven hours, and in only one hour using a 220-volt outlet. We caught up with Opener's Alan Eustace at this year's show and it was clear the company has hardly run out of money. Eustace served as Senior VP of Knowledge at Google. Opener brought on Ben Diachun to lead the company as president. He comes from Scaled Composites, bringing a long history of building aircraft (a total of 16 from clean-sheet to first flight), and is now tasked with bringing the gen-three BlackFly to market. I think this is a project to watch, if only for testing the waters of FAA and market acceptance—two huge obstacles.

Still, I think Eustace could be understating the challenges of both. "Since the BlackFly is an ultralight, we get to determine the certification requirements and safety levels," reiterating of course that the company has high safety standards. Eustace acknowledges the competition on the higher end of the electrics market, convinced that the market is exploding with evolving products that will build a new sector. In a setting where other vendors were practically on hands and knees begging for R&D money, Eustace said Opener has plenty of money in the bank to proceed at its own pace without the need to collect deposits.

An innovator showing more utilitarian products was Idaho-based Aithre, with a couple of smart devices for keeping tabs on inflight biometric data. Two products from the company that caught my eye were the Altus portable oxygen tank monitor and the avionics display-compatible carbon monoxide sensor. The O2 monitor is the result of the company founder's struggle with seeing the behind-the-seat oxygen tank gauge in his Van's RV-10, and running out of oxygen when he needed it the most.

The monitor is a simple upgrade to any tank and basically converts a portable oxygen tank into a smart device, with wireless (Bluetooth, of course) real-time monitoring of oxygen pressure, flow rate, pressure altitude and oxygen levels. It's a smart system, triggering oxygen use reminders, low-level alerts and shutoff reminders on landing. Installation takes less than 15 minutes and consists of connecting a high-pressure tee fitting between the tank and existing pressure gauge and strapping the housing on using Velcro. The device runs on four AA batteries, detects pressure changes within a 10-psi resolution, samples pressure every six seconds with a built-in pressure altimeter and throws a low-oxygen warning when it drops below 500 psi. The system is designed to work with Apple smartphones and iPads, and there's an Aithre Connect app for monitoring trend data, plus there are audible Siri notifications that work with Bluetooth headsets. I think these are products with legs.

At its booth Aithre was showing both the $350 Altus O2 monitor and the $250 Shield eX avionics-integrated carbon monoxide detector displaying on an Advanced Flight Systems display. Using Bluetooth, the company said the sensors will also work with Garmin's experimental version of the G3X Touch and Dynon's SkyView. I think these are innovative and useful products that are worth a look. Visit the company at www.aithreaviation.com. —*Larry Anglisano*

INCREASING THE TBO

I noticed that Continental just announced a drop-in replacement engine for the Lycoming IO-360 engine that's in later-model Cessna Skyhawks. I own two of these airplanes (one is on a leaseback to a busy flying school) and what got my attention was Continental's claim of a longer TBO with high usage. What does the manufacturer consider high usage and do you know anything about this engine?

Thanks for your consistant excellent work—I'm a lifetime subscriber.

Joseph Aberdean
via email

The Continental engine you're referring to is the new Prime IO-370-D3A3. The company was showing it off in a Skyhawk at AirVenture last month. It's 180 HP, STC'd (for Cessna 172R/S models), has a Bendix impulse-coupled ignition, includes roller tappets and has a price of $27,226.

As for the TBO, the recommended is 2200, but that extends to 2400 for what Continental calls high-utilization aircraft. Typically these are aircraft that fly more than 40 hours per month. Continental's Service Information Letter SIL98-9C is worth reading because it addresses recommended TBO periods based on the engine model and a variety of operational factors, including high usage.

I see that Continental has an STC'd Prime IO-370 for some Cessna Skyhawk models. Will there be an STC for older Piper PA-28 models like the 180 and 181?

Daniel Barfield
via email

Actually, we asked a Continental rep at AirVenture the same question and didn't really get a definitive answer. But as he pointed out, the 180-HP Continental Prime IO-370-D3A will be used on Piper's new 100-series two-seat trainer, which is essentially a PA-28. Keep watching.

FUEL SENDER RUNAROUND

I wish you guys ran that digital fuel sensor article (August 2019 *Aviation Consumer*) last year when I committed to a JPI big-screen engine monitor for my aging Cessna 206. I was already at the threshold of my budget when I pulled the trigger on the engine monitor job, which of course included fuel quantity to replace the bouncing Cessna OEM gauges. After consultation with the shop manager, I could tell that using the existing senders would be a roll of the dice, so we ended up sending them away for a rebuild.

Long story short, the shop couldn't properly calibrate the system at the end of the job and we ended up replacing them with new digital senders like you described in your article. This added thousands to my invoice. Caveat emptor to others embarking on this project.

Phil Caldecott
Cherry Hill, New Jersey

RAT'S NEST OF WIRES

Thank you for the useful avionics upgrade article in the August 2019 issue. The article is a huge resource for planning, but I think you understated the cost for even the most basic upgrade no thanks to old wiring.

I ended up with a Garmin G500 TXi retrofit display, plus a GTN 750 GPS and GTX 345 ADS-B transponder in my B55 Baron and let me tell you, it was almost $3000 more than my shop quoted. Most of the overrun was because of old wiring that ultimately got replaced when the shop tried to wire the system into the King KFC200 autopilot. I showed up one day to have a look at the progress and couldn't believe the rat's nest of wiring bundles that ran from the nose to the panel.

My suggestion to anyone with an airplane older than 20 years is to get a quote that includes replacing the associated wiring if needed. You'll be pleasantly surprised that the job might come in under budget and ahead of schedule if it doesn't need to be replaced. That certainly wasn't the case with my airplane.

Felix Cabrerra
via email

WHICH TURBOPROP SINGLE?

I'm considering stepping out of my turbo Cirrus and into a used turboprop single. Do you plan to scan the market any time soon? If you do I'm hoping it will make me come to my senses. Thanks for a fine publication.

T.F. Barnes
via email

Come to your senses and read the report in the March 2018 Aviation Consumer.

On The Cover: That's the new Texas Aircraft Colt LSA in cruise flight. What's somewhat unique about the Colt (compared to other LSAs) is its relatively spacious cabin, big-airplane handling and decent climb performance. Paul Bertorelli's flight trial follows on page 4.

CONTACT US

Editorial Office
860-614-1987 (EDITORIAL ONLY)
Email: consumereditor@hotmail.com

Subscription Department
P.O. Box 8535
Big Sandy, TX 75755-8535
800-829-9081

Online Customer Service:
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Texas Colt: Big Airplane Handling

Many LSAs are hobbled by too-light control forces, making them iffy trainers. The Colt feels like a Cessna 150 and with a docile stall.

by Paul Bertorelli

CHECKLIST

- The Colt excels in cabin comfort and solid airplane handling.
- Dynon's SkyView HDX is a good choice for the panel, as is the autopilot.
- Although not a deal breaker, we would prefer the 912 iS over the ULS.

The idea behind the light sport aircraft rule was to stimulate new designs at affordable prices. "Affordable" is arguable, but the new designs are out there in such volume that few models have been able to rise above the noise as standouts.

The latest effort comes from a new company called Texas Aircraft with a design called the Colt. Priced at $167,000, the aircraft itself is what you'd expect of an LSA—100-knot cruise, adequate climb,

FLIGHT TRIAL

sub-500-pound payload and a price that puts it in the middle of the light sport spectrum. A basic Colt model, the S, sells for $10,000 less.

So in a market already choked with more choices than even the most diligent buyer can sort through, how can a late entrant hope to distinguish itself from the crowd? Texas Aircraft appears to be charging into the market with a two-place LSA that aspires to eventually achieve Part 23 certification and a follow-on four-place model, an ambition expressed by at least one other manufacturer—Flight Design—but thus far not achieved. Yes, Tecnam is noted here, but Tecnam began life in the world of certified aircraft and morphed downhill into the ultralight/light sport world.

FROM BRAZIL

Brazil has been a hotbed of aviation activity, especially during the past three decades. With the state-owned Embraer, Brazil became the number three producer of commercial aircraft behind Boeing and Airbus, and the former recently bought an 80 percent stake in Embraer.

Brazil has also spawned a handful of light aircraft manufacturers including a company called INPAER, whose chief designer and founder, Caio Jordão, is well known in Brazilian aviation circles. Although the company considers it a clean-sheet design, the Colt clearly springs from INPAER's original Conquest 180. That airplane was designed in the early 2000s in the spirit of the U.S. light sport rule, but it was never approved nor imported into the U.S. as such.

The basic airframe served as a developmental test bed, however, and eventually morphed into a three-place variant and even a four-place model. These sold in some numbers in Brazil under a murky set of regulations that, according to Jordão, allowed what were essentially experimental aircraft to be sold as ready-to-fly products to end customers. It was a carve out of sorts because Brazil's regulatory structure had no way to accommodate the amateur-built airplanes that owners were in fact buying and building.

The response was a regulatory stopgap that allowed manufacturers to build ready-to-fly aircraft that weren't EABs but weren't certified either. And that's what INPAER did with the Conquest until Brazil's regulations were brought more into line with the rest of the world. Somewhere north of 300 aircraft were built, a mix of two-, three- and four-place models.

Jordão says the Conquest is no longer being manufactured nor sold in Brazil, although INPAER still exists to support aircraft in the field and may eventually serve as the portal to import the Colt from the

The Colt doesn't lack for cabin space or comfort, top photo. It has plenty of shoulder room, even for pilots of girth. Dynon's SkyView HDX is standard, along with an autopilot, middle photo. Baggage compartment is bisected by a housing for control rods running aft, bottom photo.

U.S., either as an ASTM airplane or a Part 23 model, if it gets that far.

The Colt can be thought of as Conquest V2.0 and Jordão, buoyed by outside capital investment from Brazil, established Texas Aircraft in Hondo, Texas, specifically to sell into the U.S. light sport market.

The company launched in 2017 but only recently began manufacturing in volume. When I visited the factory in mid-July, several aircraft were in the works and the company was expecting final FAA approval for its ASTM compliance. The word "certification" is often used to describe this process, but it's a misnomer. LSAs are approved under ASTM consensus standards, not type certificates.

PLASTIC TO METAL

While Jordão's Conquest began life as a composite airplane with fabric wings, it eventually evolved to have all-metal, strut-braced wings. The Colt has evolved further into a metal, riveted design, but has retained the high-wing strut-braced approach. Through translator Caio Braga, Jordão said that while the Colt is informed by the Conquest, it has been modified considerably.

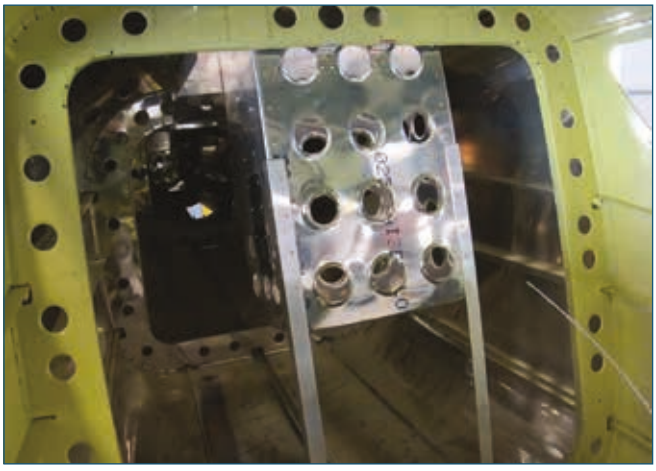
The wing was redesigned to improve the stall characteristics and the cabin is somewhat larger to improve the ergonomics. Although it's not common to see manufacturers switch from composite to metal or back, that's what Jordão did with the Colt.

He said metal penciled out to be more easily manufacturable and more structurally efficient. And with access to sophisticated CAD-CAM equipment ever more affordable, capital requirements are lower than ever for metal manufacturing.

Design wise, the Colt is largely conventional in the manner that a Mooney is conventional. It shares the Mooney's marriage of a welded chromoly cage around the cabin area to a conventional monocoque section aft of the two seats.

The wings are similarly all metal and incorporate fuel tanks in the wings for a total usable capacity of 31 gallons with a left/right/off switch on the cockpit console. The control circuitry has tubes inside the cockpit that terminate in bellcranks connected to cables to move the control surfaces.

As is the fashion for most light aircraft systems these days, the trim system is electric-only driving an elevator-mounted tab. The flaps are also electric and although they're continuously variable, the POH recommends two positions: half flaps for takeoff and full for



The Colt fuselage has a welded-steel cage attached to a conventional riveted monocoque tail section, left. The aircraft's standard equipment includes a ballistic parachute stored in a box behind the baggage compartment, lower photo.

landing. While most manufacturers have adopted Rotax's fuel-injected 912 iS, the Colt retains the 100-HP 912 ULS. Jordão said that the Colt's design brief was simplicity, reliability and ease of maintenance and that's why he stuck with the ULS. That engine is also lighter and less expensive than the iS, although it's debatable whether it's easier to maintain. The 912 ULS's carburetors require attention and we've heard owner complaints about this.

Texas Aircraft is vertically integrated with a tight production floor. It has CNC for parts fabrication, but no matchhole drilling.

CABIN COMFORT

Another complaint we've heard is that LSA cabins are tight and, oh, by the way, they have anemic payloads. In the Colt, Texas Aircraft addresses the former but not the latter. The specs give the cabin width as 42 inches or fully four inches wider than a Cessna 150. It feels that way, too. There's no shoulder bumping for normal-sized people and probably enough room for those of wider girth.

There seems to be little penalty for larger frontal area because the airplane, although not fast, is slippery. A nice touch is seats that actually slide fore-and-aft on rails instead of rudders that adjust or seat cushions that swap. The seats themselves are luxe by LSA standards and the leather-covered yoke imparts a high-end sport sedan feel, even for those of us who think all light aircraft ought to have sticks instead.

My only complaint about the ergonomics is the cabin height. It's 44 inches, but that's not the problem. Once you're in the airplane, there's generous headroom. The problem is getting in because the door has an upper sill that forces you to duck to ingress. It proved only a slight problem for my 5-ft. 8-in. frame, but taller pilots or those long of torso may struggle.

At 836 pounds empty, the Colt has 484 pounds of useful load. That's two 200-pounders and 14 gallons of gas. That's fine for a training flight, but not so fine for cross-country flying where you might also wish to carry some baggage. So if you carry full fuel, the people better not weigh more than 300 pounds total.

The baggage area is generous—38 by 22 inches with a 44-pound limit. The floor of it is bisected by a narrow rectangular tunnel that houses the elevator and rudder control circuitry, rather like the driveshaft tunnels in 1950s cars. While that can help organize the baggage compartment, it will also prevent larger objects from lying flat on the baggage compartment floor.

Even in the surface-of-the-sun temperatures of a Hondo, Texas, summer, the cabin proved surprisingly comfortable. Taxiing with doors open kept the heat at bay and in flight, a pair of adjustable scoop vents in the windows provided a cooling rush of air.

Avionics wise, Texas Aircraft installed Dynon's SkyView HDX, a well-wrought, easy-to-use EFIS system that's a good match for the airframe. It also has the Dynon two-axis autopilot, comm radio and ADS-B Out. The system has a level button, but no active envelope protection.

The version I flew had steam gauges in the right panel, but production versions won't need that, nor will discrete engine instruments be needed. The Dynon's engine

monitoring function, which is excellent, will handle that.

FLYING IT

Since I haven't flown the original Conquest 180, I can't say if the Colt iteration is a better handling airplane. But in the absolute, it's a first-rate handling airplane, in my estimation. A persistent complaint I have about light sport aircraft is too-light control forces. Some are dangerously too light, in my view.

The Colt has none of that, either by dint of the yoke or the control pivot points and design. In roll, it's pleasantly heavy—about like a Cessna 150, I'd guess. Pitch is lighter, but not to the point of twitchiness. On takeoff, I noticed no tendency to over-control or PIO because of lightness. Also, it requires little trim fussiness; trim it once and it seems to stay put. Flap deployment hardly musses its hair.

Performance is LSA-predicable. On a hot Texas day, it climbed at about 800 feet initially and easily held 600 FPM as it got into cooler air. The promo specs say 110 knots at 75 percent power. I didn't see a number that high, albeit it on a hotter-than-standard day. At about 5000 feet, the Colt settled out to 101 knots at just over 5 GPH.

Frankly, I'd be surprised to see anything different, given that light sport airplanes are designed to cookie-cutter specifications. With 31 gallons available, the airplane has a typical 550-mile still-air range. It's comfortable enough to contemplate staying in it that long, too.

If the Colt ever evolves to become an instrument trainer, it will make the pilot's life easy. In pitch, the airplane is heroically stable, damping an intentional phugoid in a single cycle with no drama. It tends not to depart in a hands-off turn and is happy to fly along level with hands off.

The stall is benign, even when aggravated. I found that like other LSAs, it has a pronounced parachute mode if the elevator is held full back after what passes for a stall break is achieved. The descent rate varied from 150 to 900 FPM and while the nose bobbles, I used only slight rudder pressure to keep the nose from yawing off into a spin entry. The airplane isn't approved for spins, but I suspect it would recover normally.

For the first landing, demo pilot Humberto Vivanco suggested 65 knots, which turned out to be way, way too fast. (It's 1.7 Vso.) For a strut-braced airplane, the Colt is slick and doesn't want to slow down. In subsequent landings, I tried 50 knots and still floated a bit. With practice, 45 knots over the fence might not be too slow. It handles forward slips nicely, too.

CONCLUSION

So where does the Colt fit in a market glutted with choices? Does it fit *at all*? Pricewise, it's closer to the top tier than the bottom. Consider that the CubCrafters Carbon Cub typically invoices for more than $200,000, but the recently introduced Vashon Ranger, at $115,000, is just more than half that. So at $167,000, that puts the Colt closer to the top tier than the bottom.

While I see the logic of equipping with a 912 ULS rather than the iS, I think the industry needs to get past carburation in new airplanes and move to ECU-controlled fuel injection. Cars have been there for 30 years. Market reaction will tell Texas Aircraft if buyers want the iS, but I certainly would, even at the expense of additional weight.

I know it will offend some to hear this, but the LSA weight limit is the most widely abused limitation in aviation. In any case, the Conquest flew at a gross weight of more than 1600 pounds, so it has the structure.

The Colt's performance is workmanlike, but not exceptional. If it stands out at all, my view is that it's a little airplane masquerading as a big one. The ergonomics are excellent and the handling is well sorted, especially if the airplane finds a home as a trainer. Teaching landings in it would be a blast.

Given the sales success of INPAER's four-place designs in Brazil, the Colt may be more a means than an end, since the company plans to evolve it first into a Part 23 airplane and later into something with four seats. In a couple of years, we'll know if they've got a good start.

LIGHT SPORT STILL A MICRO MARKET

How to describe the light sport market in a single word? Moribund is too cynical, but lively is dishonestly delusional. Let's says the patient has a pulse and leave it at that.

The chart at right, taken from data on Dan Johnson's light sport market analysis (www.bydanjohnson.com), shows that the runaway market leader, Flight Design, has placed 324 aircraft in the U.S. since 2005. Czech Aircraft Works is a distant second with 270. (I combined the Piper Sport with the Sport Cruiser for simplicity. I did the same with CubCrafters, Tecnam and Jabiru.) South of the top 10 volume leaders, the volume falls off into the multiple dozens. Johnson's data list more than 140 discrete models from dozens of manufacturers all over the world. Into that overwhelming mix, Texas Aircraft offers yet another choice at a point when the market appears to be mature to the point of pending shakeout. We've been expecting that for years, but so far, it hasn't materialized. There is a growth brand in the numbers: Icon. After a slow start, the company now has at least 98 A5s registered.

FLIGHT DESIGN	324
CZECH AIRCRAFT/PIPER SPORT	270
CARBON CUB/SPORT CUB	247
AMERICAN LEGEND	197
CESSNA SKYCATCHER	182
TECNAM BRAVO/SIERRA/P2008	179
JABIRU J-230/250	109
ICON A5	98
VANS RV-12	78
PROGRESSIVE SEAREY	66

Alternator Fixes: Repair, Overhaul, New

If a charging system problem proves to be an alternator issue, examine your options before springing for a new one. We favor Plane Power.

by Rick Durden

Yes, it's a snoozer of a topic. But that's great news. As aircraft alternators have quietly become more long-lived, they get less and less attention from owners who, rightfully, focus on the components that give them fits by breaking with frustrating regularity or require repetitive inspection or replacement. That's good, especially as some owners now have a second alternator in their airplanes to provide a backup power source as part of going to an all-electric panel and getting rid of a component that is definitely less reliable than an alternator—the vacuum pump.

Nevertheless, if you own an airplane long enough, you're going to have that disconcerting feeling of seeing a steady discharge indication on the ammeter that you can't fix by cycling the alternator side of the master switch and wonder what needs to be done to rectify the situation.

The answer to the question is twofold: First, carefully troubleshoot the problem—because about half of the time the problem is not with the alternator itself—and second, if the alternator has failed, do a little homework before you rush out and have a new alternator shipped to you overnight. You may be able to save a lot of money by buying an overhauled alternator or sending yours out for inspection and repair.

We'll talk about purchase options if it's necessary to replace your alternator. We'll say up front that we got more positive comments from users about alternator longevity than we did when we reviewed this topic six years ago. We'll also point out that we again got consistently positive comments about Plane Power alternators—with one FBO reporting that they were lasting 3000 to 4000 hours in their fleet.

CHARGING 101

The electrical system in an airplane relies on a battery to start the engine. Once it's running, it turns an alternator (or generator) to provide the power for the electrical system and keep the battery charged.

Alternators largely replaced generators in piston aircraft electrical systems by the late 1960s because alternators produce their rated amperage output at low engine RPM, unlike generators. More than a few pilots with generator-powered electrical systems have run their batteries flat taxiing in after landing at night because of the draw of the lights and avionics and the generator not putting out power at taxi RPMs.

The downside of an alternator is that it requires power to produce power—there must be electrical power in the system for the alternator to operate. If you prop start an airplane with a flat battery, a generator will produce power and charge the battery; an alternator won't. Generator or alternator aside, we are not crazy about prop starting an airplane with a flat battery as there could be safety of flight issues that caused the battery to expire in the first place.

An alternator takes the electrical power coming in through the field terminal—one to four amps—and increases it via wires rotating in a magnetic field to the rated amperage at the output terminal. A voltage regulator senses the voltage in the electrical system and varies the excitement to the magnetic field in the alternator to adjust the output

"OK, Houston, we've had a problem here." Whether an inflight charging system issue presents via annunciator or discharge on the ammeter, it requires action on the pilot's part and troubleshooting on the ground. It's typically a 50-50 chance that the alternator is the culprit.

Tech Rob Baker installing a belt-driven alternator on a Cessna P210, above right. A B&C Specialty Products gear-driven, standby alternator on the back of the TSIO-520 engine on the same P210, below right.

of the alternator. Silicon diodes in a rectifier bridge convert the AC power output from the alternator to the DC power required by the electrical system.

The alternator output voltage is always higher than the battery rating so that the battery stays charged. The battery acts as a large capacitor, helping damp voltage surges. Virtually every component in the aircraft's electrical system, especially avionics, is sensitive to voltage spikes, so an overvoltage relay is in the circuit to take the alternator offline if the voltage goes above a set level.

CARE AND FEEDING

As a general rule, an inspection of the alternator should be part of each annual and 100-hour inspection. For gear-driven or direct drive (alternators directly connected to a gear drive on the engine), the manufacturer has specific inspection requirements as an alternator failure can lead to catastrophic engine failure.

Gear-driven alternators are equipped with some form of flexible coupling that is designed to slip or fail and protect the engine should the alternator lock up. Careful installation per the manufacturer's instructions is critical.

As we were preparing this article we received word of a gear-driven alternator failure on a Cirrus that put enough metal into the engine to trash it. We cannot overemphasize following the manufacturer's installation and inspection requirements carefully.

For belt-driven alternators, inspection should include belt tension (we once ran a battery flat on a Piper Lance with a loose belt—preflight the belt tension).

The pulleys over which the belt runs need to be checked for alignment as misalignment can lead to accelerated belt wear and failure or to the belt coming off of the pulleys. The belt should be soft, flexible and free of nicks, cuts and significant wear.

Cracked alternator mounting brackets were reported to us by a few maintenance techs as occurring frequently enough to warrant a careful check each time the belts are examined.

The visual inspection of the alternator includes all electrical connections and wiring to make sure everything is secure and free of abrasion.

IN FLIGHT

Should there be a problem with the charging system during flight, the ammeter will show a discharge and, if equipped, the high/low voltage annunciator light will illuminate. On many legacy aircraft, there is no indication that the charging system has taken the day off other than a discharge indication on the ammeter. While that was standard practice in the industry for years, it means that a pilot has to keep the ammeter in her or his instrument scan, otherwise the first indication of a problem is when things get dark and quiet as the battery goes dead.

We also note that some aircraft are equipped with a load meter, which shows the load on the electrical system but not if it is charging. If your aircraft has only a load meter, we recommend making sure you find out how it indicates a failure of the aircraft's charging system.

If you do get an indication of a charging system issue during flight, the good news is that you may be able to bring it back to life. A tran-

TROUBLESHOOT FIRST

We can't emphasize the matter too stridently: Take the time to troubleshoot charging system problems—assuming that the alternator is to blame can turn what should be an inexpensive fix into a costly exercise in frustration. During our research for this article we were told by several maintenance technicians that alternators have historically been reliable and that they are steadily improving.

The rule of thumb used to be that an owner could expect to replace the alternator twice between engine overhauls. If it got to be more than twice, there was probably a problem with the charging system or cooling the alternator. Now we are hearing that alternators on airplanes that are flown regularly are lasting over 3000 hours.

With alternator longevity apparently up, we heartily echo the sentiments we heard from Mike Busch, principal of Savvy Aircraft Maintenance Management, some years ago: Don't default to an assumption that the alternator is the cause of a charging system failure.

That means pulling the charging system schematic for the airplane as well as accessing a good set of troubleshooting guidelines for the charging system. With absolutely no humility at all, we recommend the ones set out in the January 2016 issue of *Aviation Consumer.*

For troubleshooting alternators, we were particularly impressed by the flow chart-style troubleshooting guide on Plane Power's website (www.planepower.aero)—which can be used for any externally regulated alternator.

sient voltage spike will cause a voltage regulator or alternator control unit to take the alternator offline.

When you see a discharge indication, the first step is to turn off the alternator side of the master switch. If you do not have a split master switch, we recommend turning off the radios (to protect them from a potential voltage spike), and then turn off the master switch.

Wait a few moments and turn the alternator/master switch back on. There's a reasonable chance that the alternator will come back online and stay there for the remainder of your flight. Nevertheless, we think that you should discuss the incident with your maintenance tech after the flight as it may be a symptom of something that will become a problem downstream.

If the alternator does not come back online you're faced with running the battery flat within the next 30-60 minutes. The first step is to reduce the electrical load—shut off anything not essential to your flight. If you are VFR, you can probably continue to your destination or an airport with maintenance services. You may need to shut off the master to preserve the battery for later in the flight when you might need it.

If IFR, in IMC, it's time to get to VFR conditions as quickly as possible, either by diverting to a nearby airport, shooting the approach and getting on the ground or getting to VFR weather where you can safely deal with a flat battery before landing.

WHAT'S THE PROBLEM?

In researching this article, we sat down with two experienced maintenance technicians, Dave Parker and Phil Heisey of Northern Air on the Boundary County, Idaho Airport. They told us that, in their experience, about half of the charging issues they dealt with on aircraft electrical systems involved alternator failure. However, Heisey said that the most recent charging glitch he'd chased turned out to be a worn connector, something not uncommon as our airplanes age.

In general, Heisey and Parker said that in their experience, if a charging problem was not traceable to the alternator, it would most likely prove to be an issue with the voltage regulator or wiring.

If troubleshooting points to failure of the alternator (or generator), there are three options available.

GENERATOR?

We'll take a moment and talk about what to do with a failed generator. The unanimous recommendation from maintenance techs and users was to upgrade to an alternator via an STC'd kit. We saw prices for the kits starting at $495, including a new, 12-volt alternator, from Quality Aircraft Accessories (www.qaa.com). Prices go up as the alternator output increases.

We saw prices for overhauled generators starting at $360 (after returning the old generator for a core credit).

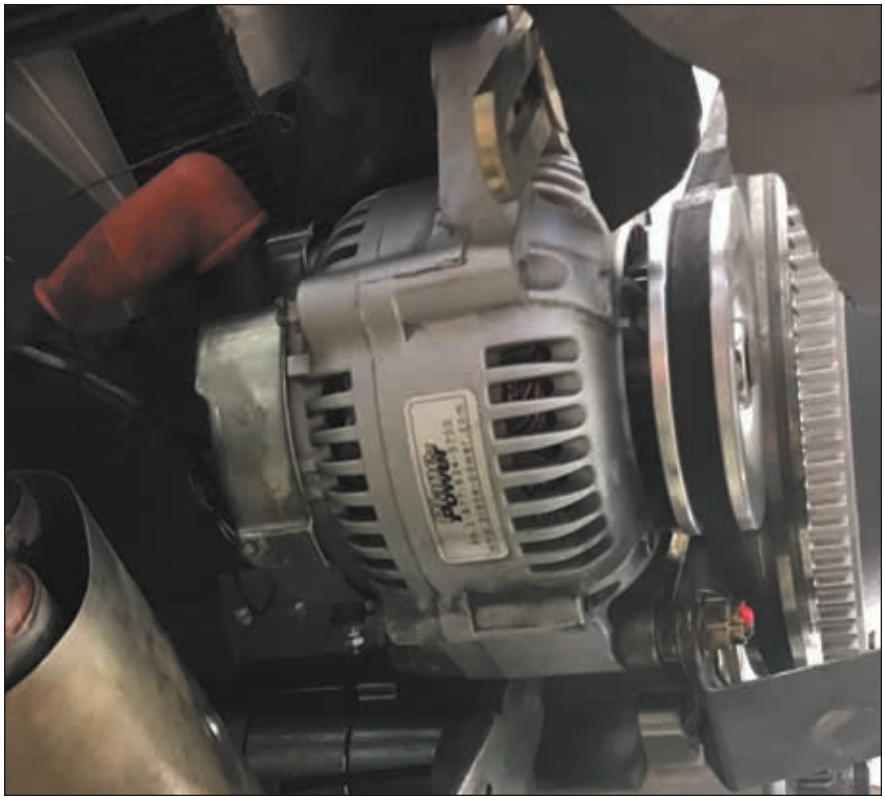
We were surprised at the relatively low prices of the alternator replacement kits. When we looked at this subject six years ago, the kit prices were about twice that of an overhauled generator. With the delta now more along the lines of 50%, we have to agree with the recommendation to make the upgrade. Not having to worry about running the battery flat taxiing in after a flight is worth the money, in our opinion. Side benefits may include some weight savings and increased reliability.

REPAIR?

When your alternator does give out, we think that the next step is most likely going to be driven by both how fast you need to be up and running again and economics.

If you have two weeks, we strongly recommend that you look at sending it to a good specialist shop with instruction to bench test or tear down the unit and advise. Within three or four days you'll find out what's wrong with the alternator, what it's going to cost to fix it

Looking up at a belt-driven Plane Power alternator on the front of a Lycoming O-320 engine on a Cessna 172, above right. The most economical approach to an alternator problem may be to inspect and repair as needed, below right.



and whether the shop recommends repair or overhaul.

It is not unusual for a $100 part and a couple of hours of labor to put it back into shape for several hundred hours of operation. In addition, the shops we surveyed offered a one-year warranty on their work.

If the problem is worse, you can have the alternator overhauled and back to you in a week or use it for core credit for an overhauled unit the shop has on hand and can ship that day.

In our conversations with maintenance techs, virtually none talked about sending alternators out for inspection and report. We heard about an owner mindset that is now geared toward remove and replace. In our opinion, that could be wasting money in the alternator world. If time is not of the essence, we recommend exploring inspect and repair rather than being spring-loaded to replacing your alternator—especially if it has been trouble-free until now.

Some of the shops that received positive comments from the people we spoke with were T&W Electrical Service (www.tandwelectrical.net), Quality Aircraft Accessories (www.qaa.com), Aerotech of Louisville (www.aerotechlou.com) and Aircraft Systems Inc. (www.acs-rfd.com).

REPLACE

We were told that when alternator replacement is needed, most owners go with the type of alternator in the airplane. We have no quarrel with that approach, although doing a little shopping might result in finding another model at a lower price.

There are numerous suppliers that can provide new or overhauled alternators overnight; your shop will probably have a favorite.

We asked maintenance techs about the reliability of new versus overhauled alternators and got the disconcerting answer: "It's a crapshoot." We heard horror stories about early failures of both new and overhauled units—although they were replaced under warranty—along with praise for long-lived overhauled and new units.

As we shopped alternators we observed that overhauled units were from 50% to 75% of the price of new (where new was available). Plan on at least $500 for the least expensive, and smallest output, overhauled alternator. Prices approach $2000 for new, high-output alternators.

As to favored alternator manufacturers, we were told that after Kelly alternators were taken over by Hartzell Aerospace, their quality improved. We also heard nothing but praise for Plane Power alternators from users and techs. For the first time since we've looked at the subject of alternators, we received no bad reviews for any type.

As we go to press we note that respected alternator manufacturer National AirParts closed its doors last April. The phone is not being answered, so we were not able to determine if National approved any shop(s) to repair or overhaul its line of alternators. If you have a National alternator, it may be an orphan. We'll keep you advised if we hear news that any shops are approved to repair and/or overhaul those units.

CONCLUSION

When the charging system discharges, troubleshoot it carefully because it's a 50% chance it's not the alternator. If it is the alternator and you can afford the time, we think that you can save money by sending it out for inspection and, potentially, repair. If replacement is required, we lean toward Plane Power units.

AirVenture Diary: Certification Promises

From new airplanes to new avionics, there were lots of delivery promises made. Epic Aircraft and BendixKing were standouts.

Staff report

Another AirVenture at Oshkosh is in the tailpipe and keeping with tradition, it's time for our show diary highlighting stuff that caught our eye, and products we're watching moving forward. First, some stats on a record-breaking year—which happened to be show number 50 there at Oshkosh.

At approximately 642,000, attendance was up 6.8 percent from 2018's record total. There were 16,807 aircraft operations at AirVenture's Wittman Airport, and plenty of others at surrounding airports.

The vendors we talked with seemed happy (especially the ones selling avionics), and there were a total of 863 of them this year. Why so happy? Perhaps it's because many were reporting that customers seem willing to spend money—a change from previous years.

BENDIXKING

BendixKing is banking on customers spending money on several products that after years in development finally have FAA approval.

The first one is the KI300 retrofit EFIS, also known as the AeroFlight. What buyers might really care about the KI300 is that it's an approved replacement for the aging and maintenance-intensive King KI256/255 vacuum-driven autopilot gyro. This instrument is an integral component in a variety of King KFC-series auto-

pilots because it provides pitch and roll reference to the autopilot.

Priced at $5330, the KI300 has a backup battery for powering the display for up to one hour, has speed and altitude tapes (which can be turned off) and can be installed as the primary (or backup) attitude indicator as long as the airspeed and altimeter indicators are retained. The initial STC includes the Piper PA46 series, but the company said a wide variety of approvals will follow within weeks. I found the instrument to have a decent display, plus it has a stone-simple feature set.

The company also showed up with an STC for the KFC230 AeroCruze autopilot it previously announced. This is designed as a drop-in replacement for the KFC/KAP 150-, 200- and 225-series analog autopilots. Priced at around $10,000, the AeroCruze uses most of the existing autopilot wiring (the mounting tray needs to be changed) as well as the existing autopilot servos. The KFC230 has a color touchscreen feature set, which has a screen layout that can be custom configured. BendixKing is also covering the existing autopilot servos with a two-year warranty after the installing dealer confirms that they work correctly. That could really work in the buyer's favor as these servos can be expensive to repair—and the aging models can and will fail, based on my experience.

Last, the AeroVue Touch retrofit EFIS system that BendixKing was showing for experimental aircraft at last year's AirVenture now has an STC for hundreds of certified aircraft. Priced at $14,995, the system has a near 4K display resolution and comes standard with Honeywell's synthetic vision, electronics charting provided by Seattle Avionics and a wireless Bluetooth interface. The AeroVue Touch is compatible

BendixKing said the multi-screen version of the AeroVue Touch suite, top, will be a player for both aftermarket retrofits and for OEM applications in turboprops and jets. The KI300, middle, can finally replace the ancient KI256 flight director gyro. That's a model of the uAvionix skyBeacon X dual-antenna ADS-B system, bottom.

with third-party avionics including Garmin and Avidyne GPS navigators and can display a variety of traffic and weather sensors.

But the real surprise from BendixKing is that its parent, Honeywell, purchased autopilot manufacturer TruTrak Flight Systems—an innovator in experimental-class autopilots that recently added applications in the certified world.

TruTrak's current leader, Andrew Barker, will continue in his role under the new ownership, and BendixKing will absorb at least some of TruTrak's engineering staff. BendixKing has a recent history of renaming and selling third-party equipment (including Avidyne navigators and JP Instruments engine monitors). We'll take a closer look at the BendixKing product line in an upcoming article in *Aviation Consumer.*

UAVIONIX TACKLES CANADIAN ADS-B DILEMMA

The uAvionix booths at AirVenture were packed layers deep with last-minute ADS-B buyers as the 2020 mandate was 23 weeks away. But high on the list of ADS-B equipage concerns is the developing ADS-B space-based Aireon tech in Canada (and the U.S. aircraft that will fly there), which looks to require diversity systems, or those with dual antennas. The effort to install that second antenna could easily blow a "budget" upgrade for simpler aircraft—a market that uAvionix has essentially taken over with its skyBeacon and tailBeacon products. So with a clever but obvious tech redesign, uAvionix is testing a second blade antenna on the current single-antenna style skyBeacon design.

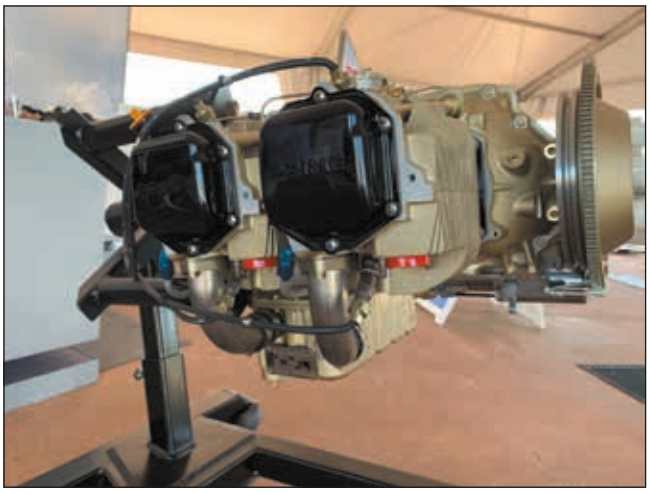
Like the original skyBeacon, the skyBeacon X is an LED position light replacement, but has an integrated 1090ES transponder (and WAAS GPS), plus a baro altimeter. The company says it might be ready in 2021, and it hasn't mentioned pricing, but uAvionix President Christian Ramsey hinted it will be budget-based. "We specifically designed the skyBeacon and tailBeacon to target a low cost of installation, and we are doing it again with the skyBeacon X," he said in a news release.

uAvionix reiterated that back in January 2019, Nav Canada announced it will be implementing ADS-B airspace performance requirements in three phases. Phase 3, to be implemented no sooner than 2023, is the biggest impact on GA operations and will require ADS-B Out systems with two antennas—one on the top and the other on the bottom—of the aircraft. Don't overthink the tech: Since Aireon is satellite based, an antenna on the bottom of the aircraft won't do much for performance, or specifically, the aircraft's ADS-B Out data update rate.

The skyBeacon X testing, so far, shows that the new design can work well out on the wingtip for both ground and satellite signals.

EPIC AIRCRAFT E1000

Years in development, the Epic



That's the Continental Prime IO-370 that's STC'd for Lycoming-equipped 172 models, top, and a new electronic ignition module from Lycoming, bottom.

E1000 turboprop single could finally be close to certification, the company said in a press conference at AirVenture. Doug King, Epic's CEO, told reporters that the company had completed all of its internal flight testing leading up to certification and has received its type inspection authorization. That means the Epic has passed the last hurdle before the FAA begins its flight-test review.

Certification is expected in 2020. Production will begin shortly after the type certificate and production certificates are approved; the PC is being sought in tandem with the TC. King says that the first three customer aircraft are already under construction in Bend, Oregon. The 300,000-square-foot facility will build one aircraft a month to start but is designed to build as many as one a week. Including a full Garmin avionics suite the 333-knot Epic carries 1100 pounds and costs $3.25 million.

While on the subject of turboprops, Textron was showing off a full-scale cabin and cockpit mock-up of the Denali turboprop single it announced in 2016. The company said it plans to enter flight testing with the prototype by the end of 2019.

The 1300-SHP Catalyst FADEC engine will be provided by GE Aviation, is being developed specifically for the Denali and will spin a digitally controlled McCauley five-blade composite propeller. The engine is slated to have a 4000-hour TBO, but a 5000-hour TBO is the ultimate goal. The Denali is expected to have a 1600-mile range and typical fuel burn of 60 GPH, while the single-pilot aircraft will have a service ceiling of 31,000 feet. The aircraft will have a digital pressurization system that maintains a 6000-foot cabin at 30,000 feet.

A DROP-IN CONTINENTAL FOR SKYHAWKS

Continental announced a new STC to install its Prime IO-370-D3A3 engine into Cessna R- and S-series C172s—a retrofit that could actually cost less than overhauling the Lycoming IO-360 it replaces.

The Prime IO-370-D3A3 delivers 180 HP, includes roller tappets and comes with a recommended TBO of 2200 hours that extends to 2400 hours for high-utilization aircraft. The STC includes the engine, a Bendix impulse coupled ignition system (to provide improved starting and reduced magneto maintenance, Continental says), a starter, fuel system and associated STC paperwork to complete the installation on Cessna 172s currently using a Lycoming IO-360-L2A engine. The STC is priced at $27,226 and comes with a two-year warranty.

FOUR-SEAT LSA?

Four years from now, sport airplanes with four seats might just be a thing, according to Dan Johnson of the Light Aircraft Manufacturers Association. In a press briefing, Johnson said the FAA has adopted a formula called a power index that factors in horsepower, wing loading and total vehicle weight. As long as the aircraft fits within the power index confines, there's no specific limit, Johnson said. "But they can definitely be larger because what they're adding into this now, that no one expected, is up to four seats," he added. The overarching goal is to keep wing loading and stall speeds low as a safety enhancer. "Obviously, if you have a number that's way up there beyond 3000 pounds, which is way beyond the current number—that's going to require that aircraft have a substantial wing and enough horsepower so it can keep the stall speeds way down low and be easy to operate," Johnson said.

LYCOMING'S NEW IGNITION

Lycoming debuted a new electronic ignition meant to be a bolt-on replacement for conventional magnetos. Dubbed the Electronic Ignition System (EIS), the devices have no internal moving parts and slip right into conventional magneto housings on four-cylinder Lycoming engines.

The company is working toward FAA certification for retrofits, so it's still only fair game for experimentals. One exception is the CarbonCub XCub, which debuted this system with its CC393i. Also, six-cylinder versions are in development.

For certified aircraft, the EIS initially will be configured for fixed timing, like a magneto. The initial approvals are expected in the third quarter of this year, with Lycoming continuing development of a variable-advance version in early 2020. No pricing has been set, but Lycoming said it will be competitive.

Which IFR Navigator? Garmin GNC 355 Wins

But it's not a slam dunk. We think it could be better if it had an ADS-B transponder, plus select buyers might miss the ILS.

by Larry Anglisano

When Garmin introduced the GPS 175 (and ADS-B transponder-equipped GNX 375) budget IFR navigator earlier this year, we wondered why it didn't have a comm radio. Then a couple months later, Garmin tossed the $6995 GNC 355 in the mix with, you guessed it, a built-in comm.

That leaves no fewer than a half-dozen choices for new GPS navigators, counting ones from Avidyne and not counting some worthy used-market choices. In this article, which is part of our Avionics Bootcamp series, we'll attempt to sort out the buying decision so you're better prepared to round up some quotes for installation.

To do that, let's look at three real-world upgrade scenarios and what we think are the best possible solutions, mostly from an interface standpoint. You'll have to answer for yourself how you might fly with the tech once it's in.

For starters, ask yourself if you can fly without a ground-based VHF nav, including raw-data ILS. You'll see why.

NAVIGATOR REWIND: GARMIN GNC

It was around 1996 or thereabouts when Garmin started cranking out the GNC 300XL. This was a TSO C129(A1) IFR approach GPS navigator and as a bonus, it had a utilitarian moving map (of course, any panel map back then was utilitarian) and a built-in VHF comm radio. It had no VHF nav—strictly GPS. The GNC series was a clever idea and almost the perfect solution for backing up a traditional navcomm, or for more basic panels, it worked as the primary rig because of the built-in comm. The cheaper GNC 250XL had a VFR GPS and a simpler install. The GNC series sold like rush-hour coffee at Starbucks.

Garmin killed the line some years back, and now brings it back with the GNC 355. We wrote about the first products—the ADS-B equipped GNX 175 and entry-level GPS 175—in the May 2019 *Aviation Consumer*.

Avidyne's IFD440, bottom radio, is a direct drop-in for discontinued Garmin GNS 430W navigators. The GTR 375, middle, has a mandate-compliant ADS-B transponder, while the GNC 355, top, has a comm radio, but no ADS-B. Copy all that?

Like the 175 and 375, the new comm-equipped GNC 355 has a 2-inch-high bezel, which helps differentiate itself from the larger GTN 650 navigator, nor does it have a VHF nav receiver.

Like the other two budget units, the idea with the GNC 355 is to replace aging navigators without having to do much if any stack rework. Maybe there's an old Apollo GX60, King KLN89B or even a King KX155. The GNC should easily fit in without restacking.

Like the other two units in the series, the GNC 355 is designed to work with a variety of third-party nav indicators. Remember, these

NAVIGATOR RUNDOWN			
MODEL	PRICE	DISPLAY (INCHES)	COMMENTS
AVIDYNE			
IFD550	$21,999	5.7	Flagship box with ARS (attitude), dynamic synthetic vision, wirless. GNS 530W drop-in.
IFD540	$15,999	5.7	A scaled-down IFD550—no ARS or dynamic syn vis. IFD545 doesn't have comm or nav.
IFD440	$11,999	4.8	Easy drop-in when replacing a Garmin GNS 430W. Has comm, nav, WAAS and 3D syn vis.
GARMIN			
GPS175	$4995	4.8	LPV approach capability, touchscreen, wireless flight data streaming, 2-inch bezel height.
GNC355	$6995	4.8	Same as GPS 175, but adds a 10-watt onboard smart-comm radio.
GNX375	$7995	4.8	No comm radio, but has a built-in1090ES ADS-B transponder.
GTN650	$11,995	4.9	If you can't go without ground-based nav, pay a $5000 price delta for this.
GTN750	$17,495	6.9	Garmin's flagship big-screen navigator, pairs with the GMA35 audio system.

boxes are WAAS equipped for full IFR GPS approach capability, so you still need an indicator to display course information. The new series has Garmin's Connext wireless interface for traffic, weather and flight plan streaming to and from a tablet.

There's a long list of compatible indicators—everything from Garmin's own GI 106A/B to the King KI209 and KI525A HSI—even old Narco and Collins indicators. But we suggest asking your shop if these indicators are healthy enough to retain for reliable service. Some are not. The unit will also work with new stuff—including Garmin and Dynon EFIS.

The new touchscreen mapcomm is intended for Class I/II aircraft that weigh 6000 pounds or less, and can be installed under a 700-aircraft blanket AML-STC.

Let's look at a couple of navigator upgrade strategies. These examples are aircraft owned by actual readers who we recently helped noodle the upgrade decision.

PIPER CHEROKEE

If you own something like the Piper Cherokee panel shown below, it's begging for an upgrade. The first thing we would do is remove the King KR86 ADF system that's at the top of the right stack. At the same time, get rid of its antennas and reap the benefits of a cleaner airframe. Below it in the stack is a King KLN90B approach GPS that's installed for VFR. Out with it. A CRT display failure makes it a boat anchor.

This aircraft has already been upgraded with a uAvionix skyBeacon, so it's ready for the 2020 mandate. But it has an old tube-powered transponder that won't last much longer.

With dual KX170B navcomms, this panel is the poster child for Garmin's new GNC 355 mapcomm. You could even retain the second KX170B as a backup radio and install the GNC 355 as the primary. It'll work well for instrument training and make for an efficient radio stack. Since the glideslope receiver is built into the primary KI214 nav indicator, you could drop it down and use it as the secondary system—if it works. We say yank it out and save some weight. The KI214 retired long ago.

At the end of the day, this will be a $10,000 upgrade, but with a new transponder (maybe Garmin's GTX 327 Mode C unit) and the antennas and other cleanup work, plan on $14,000. If you want to ditch the KMA20 audio panel for something newer and more capable, you're well north of $16,000.

CESSNA 182N

This late 1980s panel has a non-WAAS Garmin GNS 430 with Garmin GI 106A indicator, plus a KX155 with KI208 indicator as the secondary system. The aircraft has a Garmin GTX 327 transponder and it needs ADS-B. The goal here is to jump into the world of WAAS approach capability and out of the aging GNS 430. The airplane has an S-TEC 50 two-axis autopilot with nav tracking and also a GPSS steering system.

One relatively easy upgrade for this panel is Avidyne's IFD440. It can slide into the GNS 430 wiring and work just fine with the Garmin indicator and with the S-TEC autopilot. But since the IFD440 is a WAAS unit, it won't work with the existing Garmin GPS antenna and cabling. The shop will need to remove the headliner, change the cable and install the WAAS antenna.

Avidyne's IFD440 retails for $11,999 and you might get a trade-in of around $2000 for the non-WAAS GNS 430 that comes out.

Another option for this panel is Garmin's GNX 375, which will solve the ADS-B dilemma and add LPV approach capability. But unlike the Avidyne IFD440, it doesn't have a comm radio and it doesn't have a nav receiver. That means you're relying on a single comm radio (with

For easily replacing a Garmin GNS 430, we like Avidyne's entry-level IFD440 shown in the panel at the top. If it's replacing a WAAS-capable GNS 430W, middle, you could score a generous trade-in or sell it on the used market. That's a Garmin GI 106B nav indicator, bottom photo, which works with all of Garmin's navigators.

the KX155) and going without ILS capability. Decisions, decisions.

BEECH SKIPPER

You just bought a little Skipper for knocking around the local area, but you want to start doing some instrument training. It's not going to happen in this airplane with the single Narco navcomm radio with a nav indicator labeled "Inop." The previous owner spent some money on new gyros and installed a Garmin GTX 327 transponder and a new altitude encoder, but no ADS-B.

For this we think Garmin's new GNC 355 is the right solution. It will bring a reliable comm radio and of course the utility of an IFR GPS so you can get started on your training. The fly in the ointment is that old Narco VOA-series indicator that needs to be replaced. Maybe your shop has a used King KI209 (around $900 for a good one), or spring for a new Garmin indicator for $2350. Price a G5.

As for ADS-B, this is the perfect application for the uAvionix skyBeacon. When the dust settles, plan on a $12,000 upgrade.

NOT A SLAM DUNK

We can't come close to covering all of the panel combinations, so if you have one you're struggling with drop us a line and we'll take a look.

We can say that while Garmin's new line of budget navigators can be a dollar saver (the GNC 355 mapcomm is $5000 less than a GTN 650), it also muddies the buying decision. For example, a lot of panels need a new comm radio, transponder, GPS and ADS-B, but the GTX 375 falls short for these applications for not having a comm. The new GNC 355 does, but it doesn't have the ADS-B transponder. That leaves a hole in the line filled by the higher-priced GTN 650, of course. We asked Garmin why it didn't include the ADS-B transponder in the comm-equipped GNC 355 and it said the transponder simply wouldn't fit in the chassis.

This aside, there are still a lot of panels equipped with the older Garmin mapcomms and in our view the new GNC 355 is hands-down the best option for replacing them. Unfortunately, the unit (and the others in the series) isn't pin-for-pin compatible with the old wiring. The boxes are too different, says Garmin.

But from a panel real estate standpoint, the units will drop in place of many older GPS units (or navcomms) with minimal amounts of stack rework. That means a quicker install. As for space behind the panel, the entry-level GPS 175 is the most efficient. It's only 6.58 inches deep, which follows the design of the original GNC 250 from years ago.

The other thing we like about this new line is Garmin made the units compatible with a ton of older analog autopilots—everything from a basic Cessna 200A to S-TEC 60-2. If you are considering a budget EFIS upgrade at the same time, they'll work with Aspen's VFR display, and of course Garmin's own G5 EFIS.

What makes the buying decision real muddy is that none of these budget navigators have ILS receivers and only you can decide if you're comfortable doing without, based on where and how you operate the aircraft. At 4.8 inches diagonally, the display is small, but the savior is the wireless interface for tablets running the Garmin Pilot or ForeFlight apps.

For higher-end rides—we're talking twins and go-places complex pistons—full-up navigators like the Garmin GTN and Avidyne IFD will be the boxes of choice for ILS capability. But for basic panels begging for a modern upgrade that won't break the bank, we favor Garmin's generously equipped GNC 355.

USB Panel Power: Certified For a Price

There are lots of cheap lighter-socket USB plugs, but for those willing to pay for FAA approval and smart charging, there are plenty of options.

by Phil Lightstone

CHECKLIST

- When ports are installed correctly, you'll never have to worry about smoking your portables.
- True Blue Power has the widest variety of models to choose from.
- Expect an invoice well north of $500 after installation.

When I started flying in 1994, there certainly wasn't the need for accessory power in the cabin. These days it's an entirely different story and the number of portable devices I carry grows by the month. Who thought you would have to charge your sunglasses? That's why the market is being bombarded with panel USB charging ports. These are generally FAA-certified devices that mount either on the instrument panel or in interior components, and connect with the aircraft's electrical bus for voltage.

But if you check the prices on these things you'll be shocked to see them selling for hundreds of dollars, not counting installation. Are they really any better than hardware store USB ports that plug in to a cigarette lighter socket or even portable power banks that might sell for under $20?

In this article we'll attempt to answer that and look at what's available for installation.

SMOKE SHOW, ANYONE?

The price point for panel USB receptacles has become controversial, with buyers squawking about the several hundred bucks these things cost. The counterpoint is you might get acceptable performance from cheap models sourced from auto parts stores. But some users we spoke to said off-the-shelf plug-ins generate excessive audio system noise in their aircraft, so they really aren't worth it. Let's look at the tech, starting with input voltage considerations, and the caveats of playing with the wrong voltage.

For instance, many general aviation birds have 12-volt electrical systems. And there are a number of aircraft, like my Commander single, that have 28-volt electrics. Plug a 12-volt device into a 28-volt power source and it will smoke. And you'll know when it's smoking by the smell of acid under your nose. Yes, replacing a $1000 smoked iPad makes for a bad flying day.

Tech tip: Plug in the power adapter while the aircraft is on the ground—and without your smartphone or tablet attached. If it smokes, you'll have destroyed a $5 adapter, not a $1000 tablet. Consider that USB cigarette chargers vary in terms of their supported voltage. Some—not all—of these devices are rated to handle 28 volts. In the Commander, the cigarette charging port puts out 28 volts, which is enough to smoke an inexpensive power adapter. I've seen one smoke, and was able to extinguish the burning circuit by quickly chopping the master switch.

Still, there are a number of manufacturers who build power adapters rated between 12 and 32 volts DC, which are perfect for our 28-volt ships. Or, follow the lead of OEMs that are generous with cabin USB as standard (Cirrus, we think, nails the USB interface) and install a TSO'd USB port on the panel and connect it to the electrical bus.

We looked at these last in the March 2017 *Aviation Consumer*, including the True Blue Power TA102 and Guardian model. Since then, both lines have been expanded and both Garmin and Appareo sell panel power ports, too. More on those, after a quick lesson in the often misunderstood types of USB.

While often associated with USB 3.1 (and 3.2), USB-C is not the same thing. USB types, like A, B and C, denote the shape and form factor of the port

Garmin's GSB 15, shown here, has dual 18-watt USB Type-A charging ports, FAA certification and a $349 price tag.

and connector, rather than the data transfer speed. Many modern devices have moved away from the classic USB-A, USB-B and Micro-USB ports to USB-C, which is small, reversible and often goes hand-in-hand with faster transfer speeds.

You can identify the type of USB port or cable connector through the color of the plastic connector. USB 3.0 is blue, USB 2 is black, while USB-C is a small micro connector. The other big difference is that USB 3.1 draws 3 amps at 5 volts. USB-C has been used by manufacturers like Samsung for years, while Apple's iPad Pro 11- and 12.9-inch models have USB-C ports. All USB-C cables must be able to carry a minimum of 3 amps (at 20 V, 60 W), but can also carry 5 amps (at 20 V, 100 W). USB-C to USB-C cables supporting 5 amps contain e-marker chips programmed to identify the cable and its current capabilities. These e-marker chips allow the charger and device to auto-negotiate a power setting. Who would have thought that cables would become "smart"?

GARMIN GSB 15

Garmin's just-released GSB 15 is a TSO'd USB Type-A charging hub. With dual USB ports, it delivers 3 amps per USB port and measures just over 1.5 inches square and less than an inch deep. Garmin said it built it to be one of the smallest dual-port USB hubs designed for aviation.

It comes in two flavors—one for wiring into ship's power from the back of the unit, and one that connects from the bottom of the case. Smart. Installers will need to use a 5-amp circuit breaker for protection, not included. Halo lighting around the exterior of the ports keeps you from searching for it during night ops.

GUARDIAN AVIONICS

The company's flagship power hub is the $299 smartPower IFDR 250-101. We like that the unit has front and rear connectors for tying in with Guardian's smartPanel iPad/iPhone mounting system. It's a clean install because the smartPanel mount's lightning cable will connect to the rear of the IFRD-250-101, keeping the wires behind the panel.

The 250-101 series can be purchased in a variety of configurations, including one that fits a 0.9-inch cigarette lighter socket. There's also a square version for more custom installs. For cigarette lighter conversions, remove the old socket and replace it with the 250-101 and connect it to a recommended 2-amp circuit breaker.

The model 250-201 uses a remote power supply—a small box for fitting behind the panel and connecting with the electrical bus and a 9-pin cable for routing into the cabin. It's a good option for installing multiple power hubs in larger cabins. A variety of cables can be added to the 250-201, from lightning cables to USB Type B ports. The 250-101 port has green LED internal backlighting and includes a one-year limited warranty.

As for approval, all smartPower 150/250 USB power supplies from Guardian Avionics are approved for installation in certified aircraft and rotorcraft under 14 CFR Part 23, 27 and 29 as "Non-Required Safety Enhancing Equipment" (NORSEE) as outlined in FAA memorandum number PS-AIR-21.8-1602.

Guardian sells a 2.25-inch panel mount instrument adapter for $50. With it you can fit the port in a clock-size instrument cutout.

Shops tell us the $299 Appareo Stratus Power port, top, is a strong seller. The True Blue Power MD93, middle, has a clock/timer. That's the company's USB-C port below.

TRUE BLUE POWER

True Blue is a division of Mid-Continent Instruments and Avionics, populating the OEM (from pistons to airliner cabins) and retrofit market with a variety of power supplies. True Blue Power has three USB charging products, with a new product to be launched in Q4 of 2019. If you're sourcing a used power supply, know what you're buying.

MONEY SAVER

If you're not ready to drop the money on a panel USB power supply, or if you're a renter and need to bring your own, I'm still pleased with the performance of the $80 Sporty's iPad charger shown here. It's proven well up to the task of charging my portable gear on the fly. With 20,000 mAh of capacity (three times the power of the typical iPad), the battery has more than enough juice to charge action cams, stabilizers, ADS-B receivers and of course an iPhone and iPad at the same time. The battery has its USB output ports well positioned on the front edge of case. There are three standard USB-A output charging ports and one USB-C output/ input port. A power switch, LED status lamps and Micro-USB port are on the side of the case. I'm never without juice.

—Larry Anglisano

The first product to market was the TA102, with USB Type A ports. The TA202 was released in 2016 and can be configured with USB Type B and/or USB-C ports. The MD93 is a digital clock with two USB Type A ports (the MD93H has high-output 3-amp ports).

It's a confusing, but complete, product line. The main differentiators between the TA102, 202 and 302 are: the type of USB ports, maximum wattage output and amps per port. True Blue's latest USB power product, the TA302, is expected to receive FAA TSO approval later this year.

The TA line allows for drop-in replacement when upgrading an existing power supply to an upgraded model. This is important in a world of changing charging tech. The task is to simply unscrew the unit from the panel, disconnect the wires and drop the new power supply in its place.

True Blue Power's TA202 panel-mounted USB charger is available in a variety of configurations. Think of it like Lego—single-port USB-C or USB Type 3.1, dual USB-C, dual USB Type 3.1, or one USB-C port and one USB Type 3.1 port. There is also an option for bezel lighting.

As with the TA102 product, the TA202 is small. Mount it on an empty spot on the panel or in a clock-sized hole, using an optional mounting plate.

Finally, there are options for bottom- or rear-mounted cabling, offering a few more options when panel space is tight. The TA202 specs are 3.0 amps of current per port, with input voltage from 10 to 32 VDC. The output voltage is 5 VDC (± 0.25) per port, able to charge one or two devices simultaneously at full power. There's also short-circuit, over-current and over-temperature protection—good features.

The TA302, expected by the end of 2019, has USB-C as standard and will be available in half-dozen configurations of USB Type A and USB-C with 3 amps of output per port. Unlike the TA102 and TA202, the TA302's output voltage is variable, supporting 5, 9, 15, and 20 VDC. The TA302, when configured with Type A ports, is limited to 15 watts (5 VDC at 3 amps). Pricing will range from $412 to $751.

APPAREO, BENDIXKING

BendixKing recently released the $349 AeroPower panel/cabin USB charger, which is a rebranded Appareo Stratus Power device. This port has dual 2.5-amp USB Type A ports, has TSO certification and accepts 10-32 VDC input voltage.

For installation it requires a 2-amp circuit breaker for 28-volt aircraft and a 4-amp breaker for 14-volt aircraft. We say spring for a pullable breaker. The kit includes a faceplate, installation kit and a two-year warranty.

MORE OPTIONS

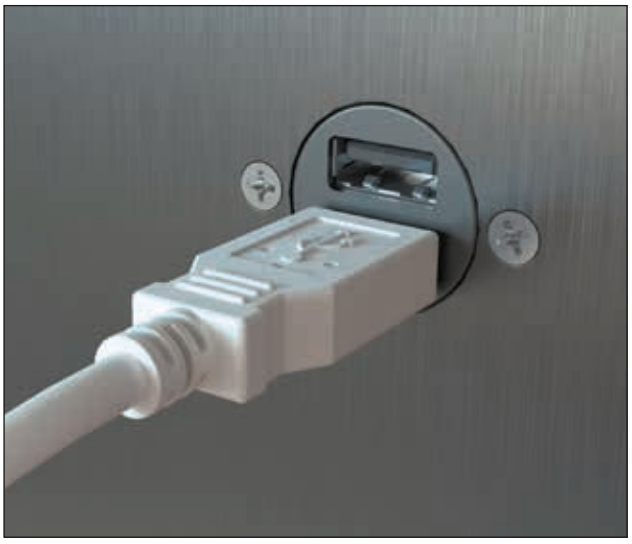
A number of avionics manufacturers are including USB ports on panel-mounted hardware. PS Engineering is one, with its $2495 PMA450B audio panel that has a USB-C charging port on the front bezel. The port provides 15 watts and 3.5 amps of power with a feature called Auto-Protection, preventing electrical shorts. The audio panel is slide-in compatible with Garmin's GMA 340 audio panel for a plug and play installation process.

Garmin's $1845 GMA 345 audio panel also has a charging port. It's rated at 10 watts of power, 2.1-amp maximum charging current and has over-current protection.

For those on a budget, or who have a limited number of devices, a cigarette lighter adapter is a must-have. While there are a number of manufacturers who make USB adapters designed for use in aircraft, there are also hundreds of cigarette lighter power chargers available at local retailers and big box stores. But as mentioned earlier, they can be a source of unwanted noise and may not be compatible with 28-volt electrical systems.

Sporty's and Aircraft Spruce, to name two respected vendors, sell a number of specialty products designed for aircraft use. Sporty's (in addition to the Flight Gear battery mentioned in the sidebar on the opposite page) has the $39.99 Front and Backseat USB charger. The plug (which is inserted into the cigarette lighter) and hub (for back-seat passengers) each have one port that is enhanced with Adaptive Fast Charge technology. These two orange ports can simultaneously charge two compatible fast-charge devices, taking them from drained to 50 percent power in 30 minutes. Sporty's has a new, smaller version of the Flight Gear Battery Pack. It's 10,000 mAh (roughly half the capacity of the full-size one), has two 2-amp USB-A ports and one USB-C port. It's small, about the size of a smartphone, and retails for $39.95.

That's the Guardian Avionics 250-101 dual USB port, top. For supplying power to multiple ports within the cabin, the company sells the 250-201 remote power supply with 9-pin interface cable, bottom, for powering multiple ports in the cabin.



We've used the Flight Gear dual USB charger, which shows bus voltage and the amount of amps the device being charged is drawing. The LED screen blinks and the device outputs an audible alarm if there's low bus voltage. There's also the $39.95 MyGoFlight DualMicro cigarette lighter USB charger. It works in 14- and 28-volt systems and has dual 2.4-amp output ports.

We've likely missed a handful of non-aviation portable chargers that will work in an aircraft. If there's a portable charger that's been working well for you, we want to hear about it.

Last, ask your avionics shop which panel charger will work best in your aircraft, and consider installing one with other upgrades. Every shop we talked with said a big percentage of its installs also includes a USB power port, with the Appareo Stratus Power seemingly the most popular.

SELECT USB POWER SUPPLIES COMPARED

MODEL	PRICE	COMMENTS
APPAREO		
STRATUS POWER	$299	FAA TSO-C71 certified, radio shielded for no VHF comm interference, dual 2.5-amp USB-A ports, cylindrical shape
GARMIN		
GSB 15	$349	Dual USB-A ports, 18-watt high-speed charging, compact size
GUARDIAN		
IFRD 250-101	$299	Dual USB-A ports, 12-watt charging, lighted bezel, panel (square) or round-hole mounting
SPORTY'S		
FLIGHT GEAR BATTERY	$79.95	Portable 20,000 mAh power bank, tested for interference, three USB-A ports, one USB-C (in/out) port, Micro-USB port, over-charge/short-circuit protection
TRUE BLUE POWER		
TA102 TA202 MD93	$372 $488 $648	Dual Type A ports, optional lighting ($407) Dual lighted ports, USB Type B-C Integral clock/timer, TSO certified, dual Type A ports

Bose ProFlight Series II: Tweaked and Improved

The original Bose ProFlight in-ear headset worked well in some turbine cockpits, but the reworked version solves some of its warts.

by Larry Anglisano

CHECKLIST

- The next-generation ProFlight Series II is slightly lighter, which means more comfort.
- Existing ProFlight models can easily be upgraded by swapping the downcable.
- Performance is still limited to jet cockpits, so the company's A20 is better suited for pistons and turboprops.

Bose specifically pointed the ProFlight in-ear ANR headset at the jet market—airliners and bizjets—when it released the product last year. As expected, the set attracted buyers flying turboprops and even quiet pistons, where the ProFlight simply doesn't work well, nor was it intended to.

But overall the headset is getting favorable feedback from the jet crowd, if not without some nits to pick when it comes to feature set and ANR performance. Bose is listening, proven by its just announced Series II ProFlight. Here's a once-over.

IT'S IN THE CABLING

As with most ANR models, the set's downcable—that's the plug-in harness that houses the control module, audio cable and microphone, which plugs into the set's chassis—has been replaced with a thinner and more flexible cable. Swapping out the downcable is also how owners of first-gen ProFlights will upgrade to the Series II.

Bose shaved a bit of weight from the new Series II, weighing in at 4.5 ounces. The first-gen set weighed 4.9 ounces. This isn't substantial, but on a headset any weight savings in welcomed.

The headset isn't small. With the adjustable head sliders not extended, it measures 8.43 by 6.34 by 3.15 inches.

Even after the improvements, the ProFlight Series II is still intended for jet ops. For our flight trial in the January 2019 *Aviation Consumer* we evaluated the headset in a new Cirrus, a Pilatus PC-12NG, Quest Kodiak Cessna 206 and Citation Mustang. As expected, it worked well in the Citation, but not so well in the turboprops for taming noise.

One otherwise clever feature that's been dinged by some users is the ANR circuit's tap control. Double-tapping a finger on either one of the earbuds puts the set in a talk-through mode, which works when the headset is in the medium or high noise-canceling profile. The idea is to enable better communications outside of the headset. Maybe it's for talking with a flight attendant, gate agent or passengers, but the talk-through feature means you don't have to take the buds out of the ear to talk with someone off the intercom. We've heard of (and experienced) some situations where the tap-through is activated uncommanded during landing and even on the takeoff roll on bumpy runways. Bose said the Series II has been tweaked so the mode is more accurate and more responsive.

Bose added winglets on the set's microphone boom for better alignment. It also made some improvements to the set's Bluetooth circuitry for better audio response.

CATERING TO AIRLINE FLIGHT CREWS

Bose said some airline crews have been requesting a version of the ProFlight that doesn't have a wireless Bluetooth interface, presumably because of the airline's ops specs. As a result, the company will offer the ProFlight Series 2 in a version without Bluetooth, and it changed the design of the set's storage case (for quicker storage and easier transport)—another change made at the request of some airline crews after using the headset on the line.

Additionally, there will be an option for custom-molded ear tips provided by Bose partner Avery Sound.

Bose said the FAA TSO'd Series II model will be available this September for $995, and existing ProFlight owners will get a price discount for upgrading to the new downcable.

Contact www.bose.com.

Sentry Mini ADS-B: Sub-$300, Compact

ForeFlight throws another portable ADS-B receiver at a crowded market. We like the compact size, but wish it worked with Garmin's tablet app.

by Larry Anglisano

ForeFlight thinks there's still a sizable market for budget-based portable ADS-B receivers so it came to AirVenture last month with a new model: the Sentry Mini. Think of the Mini—priced at $299—as the little brother of the full-sized Sentry receiver ($499) the company brought to AirVenture last year.

Like the full-sized Sentry, the new Mini is made by Montana-based uAvionix and has dual built-in antennas for receiving weather and traffic on both 978 MHz and 1090 MHz frequencies. The product's name suits it well—the device is 3.3 by 2.3 by 0.6 inches and weighs 0.1 pounds. Check that against the full-size Sentry, which measures 3.25 by 2.25 by 1.25—still compact.

The main reason for the Mini's slightly smaller footprint is it doesn't have an onboard battery. You'll need to plug it in to any 5-volt USB-C power source using the supplied cable.

NO AHRS BUILT IN

The Sentry Mini is slightly scaled back on features compared to the full-sized Sentry. It doesn't have built-in AHRS or the CO detector. It does have a built-in GPS receiver for providing position to iPads that aren't so equipped.

If you plan to use ForeFlight for backup flight instruments the Mini probably isn't the device for you because it doesn't have the AHRS sensor to feed the app. It does, however, support the full range of FIS-B weather and data, including animated NEXRAD, METARs, TAFs, AIRMETs/SIGMETs, PIREPs, winds and temps aloft, TFRs, NOTAMs, SUA information, turbulence, lightning, cloud tops and center weather advisories.

It's fully capable for use as a traffic minder. Like most modern portables it receives air-to-air traffic information from ADS-B Out equipped aircraft and rebroadcast traffic information (ADS-R and TIS-B) from FAA ground towers.

We like that the Mini has onboard memory to support ForeFlight's Weather Replay, which provides automatic storage of up to 30 minutes of FIS-B data. That means you can Sleep the iPad and then receive a burst of updates when the iPad wakes.

If there is more than one iPad connected, each iPad will be synced to have the same data replayed. ForeFlight will also animate ADS-B radar, looping up to 30 minutes of radar while in flight.

If you fly with multiple tablets or with other people, the Mini supports up to five devices on its integrated Wi-Fi network, as well as Cockpit Sharing, a feature that enables users to share routes between all devices on the Sentry Mini's network. That works for a copilot or instructor to follow along and monitor weather and traffic.

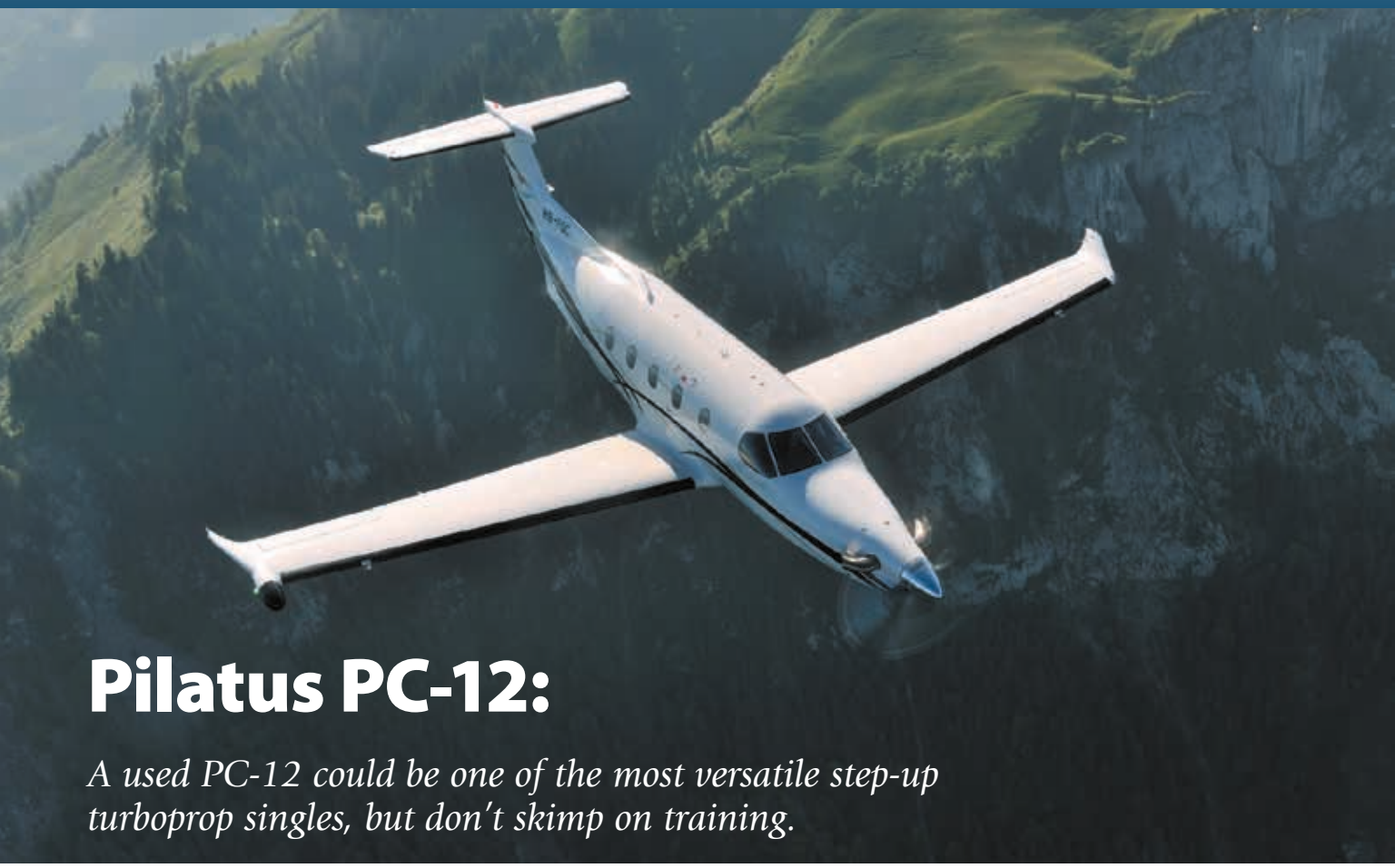
We're not fans of hanging portable devices on the windshield with suction cups, but the Mini is small and light enough where it might not be too much of a hazard in a crash or turbulence. We like that it comes standard with a high-quality and sturdy RAM suction mount.

Don't plan on using the Mini with your Garmin Pilot app (or any other third-party program) because it only works with ForeFlight. But the device is compatible with all ForeFlight subscription plans. ForeFlight said the Mini will be sold exclusively by Sporty's.

We covered all of the available portable ADS-B receivers in a roundup article for the December 2018 issue of *Aviation Consumer*.

CHECKLIST

- At $299, the Sentry Mini is cheap enough for backing up panel ADS-B In.
- The device has onboard memory for storing up to 30 minutes of FIS-B weather data.
- A panel-mounted USB power supply install can easily cost well north of $500..



Pilatus PC-12:

A used PC-12 could be one of the most versatile step-up turboprop singles, but don't skimp on training.

The PC-12 turboprop single turned out to be more versatile than perhaps even Pilatus envisioned. That's because it works just as well hauling dirt bikes (we're talking motorcycles, by the way) as it does corporate executives and charter passengers, thanks to a posh rear cabin that's configurable in several seating arrangements. Formed in 1939, Pilatus is hardly a newcomer to the aircraft market and the PC-12 has been to market since 1995. That means there is a healthy selection of used PC-12s to choose from.

But since the capable PC-12 has earned so much respect among a wide variety of operators, don't look for bargain pricing. This airplane—from the early PC-12s to the later-model PC-12NG—has notoriously maintained high resale values, especially well-cared-for owner-flown ones. Here's a look at the current market.

HISTORY LESSON

Pilatus Aircraft rolled out its first aircraft in 1945 and enjoyed much success with training and utility aircraft, including the P-2, P-3, PC-7, PC-9 and the PC-21. Before the PC-12, however, Pilatus was well known for the PC-6 Porter, a STOL-equipped utilitarian turboprop single that is popular for hauling skydivers, among filling other unique missions. But the Pratt PT6A-powered PC-12 is different, combining impressive amounts of utility with high-end styling and performance, including a nearly cross-continental range and a cruise speed that flirts with 280 knots in newer PC-12NG models.

The PC-12 has notoriously been marketed as an alternative to the King Air 200 series.

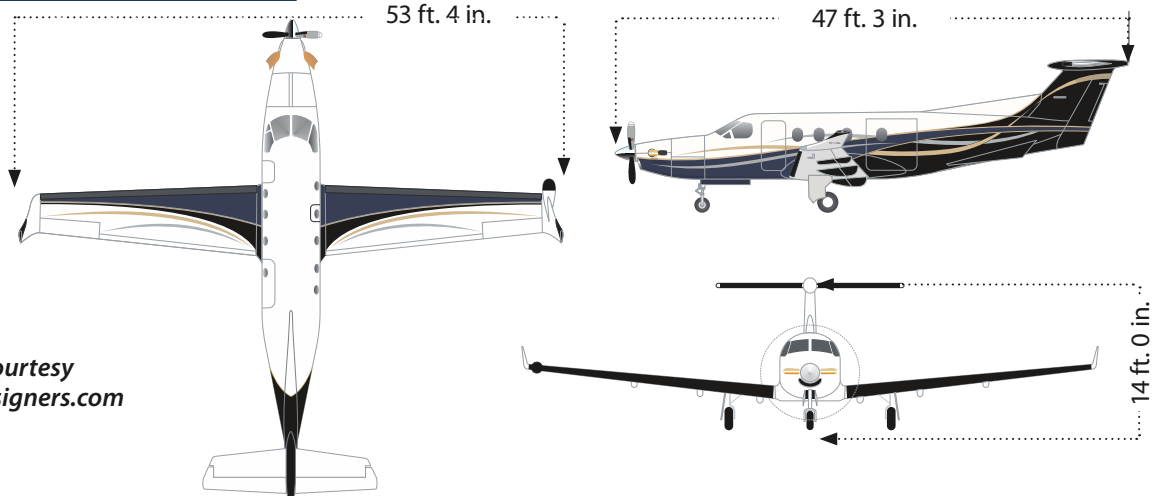
DECIPHERING THE MODELS

Surfing the PC-12 market can be tricky because of the different, yet similar, model designations. Look all the way back to when Pilatus delivered the first PC-12s in 1994, starting with the model PC-12-41, which had a 9040-pound maximum takeoff weight. If you're searching the used market for an early one, you'll be hard pressed to find a PC12-41 that hasn't be modded (via landing gear mod and a paperwork change) for a 9920-pound maximum takeoff weight, essentially making it a PC-12-45 designation—the second series of PC-12s introduced around 1996.

Up until the current PC-12NG model, Pilatus incrementally bundled modifications and improvements into 11 groups of airframe serial numbers. This means if you were to buy a 2014 PC-12 (an example for the sake of shopping the used market), it would incorporate all of the improvements made to

The PC-12 series, main image, is pressurized and powered by a Pratt & Whitney PT6A-67 engine. The typical overhaul cost is around $500,000.

PILATUS PC-12

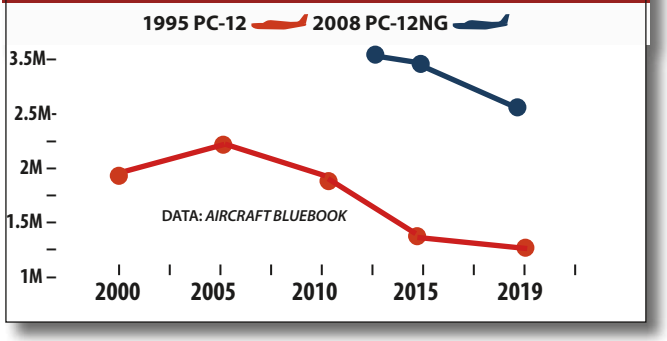


Drawings courtesy www.schemedesigners.com

SELECT MODEL HISTORY

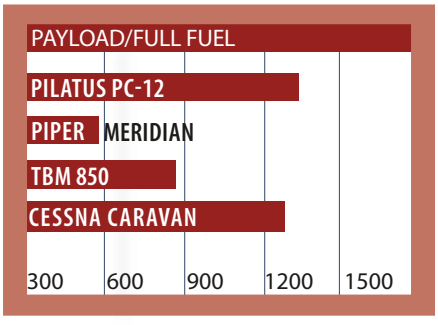
MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL (LBS)	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1995 PC12-41	P&W 1200 SHP PT6A-67B	3500	$400,000	2704	4020 LBS	270 KTS	±$1,400,000
1996-1997 PC12-41	P&W 1200 SHP PT6A-67B	3500	$400,000	2704	4020 LBS	270 KTS	±$1,500,000
1997 PC12-45	P&W 1200 SHP PT6A-67B	3500	$400,000	2704	4020 LBS	270 KTS	±$1,600,000
1998-1999 PC12-45	P&W 1200 SHP PT6A-67B	3500	$400,000	2704	4020 LBS	270 KTS	±$1,700,000
2000-2003 PC12-45	P&W 1200 SHP PT6A-67B	3500	$400,000	2704	4020 LBS	270 KTS	±$2,000,000
2002-2003 PC12-45	P&W 1200 SHP PT6A-67B	3500	$400,000	2704	4020 LBS	270 KTS	±$2,100,000
2004-2005 PC12-45	P&W 1200 SHP PT6A-67B	3500	$400,000	2704	4020 LBS	270 KTS	±$2,300,000
2006-2007 PC12-47	P&W 1200 SHP PT6A-67B	3500	$400,000	2704	4020 LBS	270 KTS	±$2,500,000
2008-2009 PC12-47E NG	P&W 1200 SHP PT6A-67P	3500	$400,000	2704	4020 LBS	280 KTS	±$3,000,000
2010-2011 PC12-47E NG	P&W 1200 SHP PT6A-67P	3500	$400,000	2704	4020 LBS	280 KTS	±$3,300,000
2012-2013 PC12-47E NG	P&W 1200 SHP PT6A-67P	3500	$400,000	2704	4020 LBS	280 KTS	±$3,500,000
2014-2017 PC12-47E NG	P&W 1200 SHP PT6A-67P	3500	$400,000	2704	4020 LBS	280 KTS	±$4,200,000

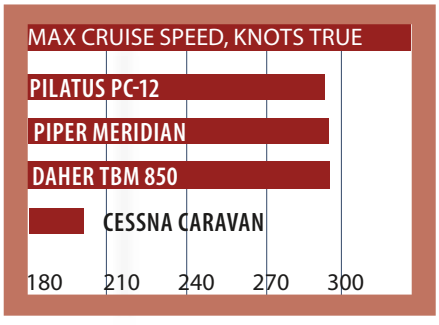
RESALE VALUES

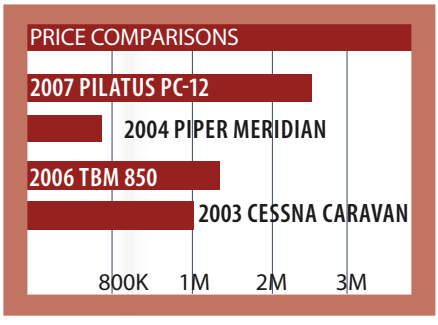


SELECT RECENT ADs

AD 2009-05-07	REAR STICK PUSHER CABLE
AD 2005-04-16	WINDSHIELD DEICE WIRING
AD 2003-20-15	FUEL BOOSTER PUMP REPLACEMENT
AD 2001-22-15	CARGO DOOR LIGHTNING HOLES
AD 99-17-01	REPLACE WING FLAP DRIVE SHAFTS







A PC-12NG's flight deck is all business. Pilatus got the ergonomics right, but we think the Honeywell Apex suite, top photo, can benefit from a modern refresh. Look for the Cursor Control Device (CCD in used models—it was a pricey option on early NG airplanes). The center power console houses the flap lever and keypad for the Apex, bottom.

the aircraft over time. But if you're shopping the used market, you'll focus on the more significant changes associated with a given series. Some upgrades (through service bulletins) were more substantial than others.

For example, the series three (serial numbers 141-160) brought the previously mentioned gross weight increase from 9040 pounds to 9920 pounds (which ultimately became standard beginning with serial number 181). Series four (serial numbers 161-180) brought new pilot and copilot seating with improved adjustment mechanisms, plus passenger seats certified for the increased gross weight. Series five (serial numbers 181-200) included new heat ducting in the cabin, a new oxygen shutoff lever in the cockpit, a 60-second engine start relay, plus head impact modifications to the passenger seating. More major modifications were incorporated in series 10 aircraft, starting with serial number 401 through 888 (later serial numbers upgraded the aircraft to the PC-12-47). This included a new EIS, which incorporated an engine condition monitoring system (ECMS), allowing the EIS to capture all critical engine parameters for download to a laptop computer for engine trend analysis. There were also some avionics upgrades, including the addition of the BendixKing KLN90B approach-approved GPS, the KMD850 multifunction display, EGPWS, weather radar and TCAS.

But the used market shows that many of these early-gen airplanes have major avionics upgrades. You'll find that the BendixKing avionics were replaced with Garmin GNS 530 and GNS 430 navigators (and newer GTN navigators), plus Garmin G600 PFD (and now the TXi displays) to replace BendixKing EFIS displays. The early models even had the Universal EFIS.

On the exterior of the PC-12, the dash 47 model brought new winglets, a new empennage dorsal fin, new ailerons for better roll handling and new LED lighting. The later series 11 is the dash 47E model PC-12NG, which begins with serial number 1001. More on this model in a minute.

SYSTEMS AND LOADING

Except for the pushrods on some sections of the ailerons, the flight controls on the PC-12 are cable driven. And unlike other turboprop singles like the Daher TBM and Cessna Caravan, the PC-12 doesn't have spoilers for roll control and that's thanks to the smaller aileron size. After some complaints about heavy ailerons, Pilatus installed servo tabs on the ailerons, which, combined with the third generation of winglet design, delivered acceptable roll forces and response, nicely harmonized with pitch and rudder forces and an aileron/rudder interconnect. Max flap travel of the big semi-Fowler flaps is 40 degrees. In flight, that allows for a dramatically steep rate of descent at 85 KIAS.

There are angle-of-attack vanes on each wing, providing data to dual AOA systems that drive a stick shaker and pusher. Stalls are prohibited, as the airplane could not meet the certification requirements regarding maximum roll-off at the stall break with full flaps and full power. AoA data is displayed on the flight director (and on the PFD in the later NG model), which makes

The PC-12's huge cargo door provides access to the rear cabin for loading and unloading almost as much as you can fit inside, top. And once inside, occupants are treated to a dwelling that follows the lead of high-end bizjets, bottom.

holding the right speed for a given landing weight easy. At max takeoff weight, stall speed is 67 knots.

Up front, a 1605-SHP Pratt & Whitney PT6A-67B spins a four-blade, full-feathering Hartzell prop. On pre-NG models, the engine is derated to 1200 SHP for five minutes on takeoff and 1000 SHP for continuous operation.

Max gross weight for the PC-12 is 10,495 pounds, with max takeoff at 10,450 pounds. The early-gen PC-12 *Aviation Consumer* flew back in 2007 for a review weighed 6474 pounds empty, giving it a useful load of 4021 pounds. With all 2704 pounds of fuel aboard, 1317 pounds may be carried in the cabin, or six 200 pounders and more than 100 pounds of baggage. For the pilot-plus-four range question used for evaluating VLJs and single-engine turboprops at the time, the answer for the older PC-12 is that a pilot plus five can still carry full fuel and go 1500 nautical miles at max speed cruise with NBAA reserves, meaning it can miss the approach and go to an alternate 100 miles away.

The zero-fuel weight is 9040 pounds, which allows a hefty 2566 pounds in the cabin. In sample loading problems, we found that with just two people up front, the airplane was near the forward CG limit. Keeping just the pilot aboard and then loading the maximum 400 pounds in the aft baggage area (behind the rear seats) and then 500 pounds in the back end of the cabin moved the CG to near the aft limit, indicating a satisfactory CG range in service. Max landing weight is 9920 pounds, so 575 pounds of fuel have to be burned off following a max gross launch.

We like that for occupant protection in an accident, no hydraulic or fuel lines penetrate the pressure vessel and the 406 gallons of fuel (402 gallons usable) in the wings (53-foot 4-inch span) is as far outboard as possible. Fuel balancing is automated, so the pilot doesn't have to mess with tank selection or take any action unless the system should fail or a line person fills one tank much more than the other.

The upside is that it was done in a fashion that fuel burn doesn't affect the aircraft's center of gravity; the downside is that there's fuel all the way to the leading edge, so it's only protected by a deicer boot and the leading edge aluminum in the event of a crash. Pilatus pointed out that the wing skin is made of stiffened clad aluminum alloy, riveted to the spar and ribs. The PC-12 does not have easily punctured fuel tanks and, to our knowledge, has never experienced a fuel leak as a result of minor wing damage or a fire due to major wing damage.

A big plus on the PC-12 is that virtually all of the systems, as well as the engine, can be accessed via doors or hatches that unlatch and swing open easily—only one access port has to be unscrewed during a 100-hour inspection. Lubrication oil quantity is checked via a sight gauge after landing, reducing the chance of engine failure because someone forgot to replace the dipstick correctly. The oil filler cap has a vertical stripe of paint on it to quickly indicate if it's correctly screwed on.

CABIN, JET-LIKE COCKPIT

Pilatus has notoriously tried to sell the PC-12 as an alternative airplane

PC-12 PRANGS: IMC LOSS OF CONTROL

There have been about 1600 PC-12s built—yet our search only revealed 28 accidents. We were encouraged by the low rate of serious accidents for the fleet—an indication that operators take training and maintenance seriously.

Nevertheless, six crashes involving loss of control in IMC got our attention. That seems high to us for turboprops, even owner-flown ones. In one accident, the investigators could not determine if the autopilot disengaged or would not engage; however, it appears that the pilot was distracted by an autopilot issue and did not focus on flying the airplane after entering clouds shortly following takeoff.

One pilot was cruising in IMC with the autopilot engaged. He commanded a course change and had the autopilot disengage during the turn. As the bank steepened and the nose dropped into a diving spiral, the pilot made the decision to conduct an autopilot test. The autopilot tested appropriately while the bank increased to 75 degrees and the speed climbed to more than 150 knots above Va. The pilot than pulled hard on the yoke and the airplane came apart. The pilot had been through PC-12 training, but he had never flown a turboprop before buying the PC-12 five weeks earlier, and he had not flown in IMC in over seven years.

A pilot took his PC-12 to FL300, slightly above the maximum operating altitude. While in cruise, he reported to ATC that he had a "panel failure." He did not give more details before entering a diving spiral that continued to ground impact.

A tragic and well-publicized accident involved a professionally flown PC-12 in which the decision-maker apparently never used the anti-icing additive Prist in the fuel. Loaded 600 pounds over gross, with four passengers more than there were seats, the pilot launched from Oroville, California, for Bozeman, Montana. At FL250 the moisture in the fuel turned to slush leading to both the left and right boost pumps running to try and get fuel to the engine at the needed rate. The boost pumps normally only activate to balance the fuel between the wing tanks.

The result was an increasing fuel imbalance—left wing heavy. Approaching the destination, the imbalance became so bad control of the airplane became questionable and the pilot diverted to a nearer airport. By then, the left tank was nearly full of fuel and the right tank empty. On slowing down in the pattern the airplane rolled left and crashed; all 14 aboard perished.

A PC-12 carries an impressive load, but it has its limitations. A pilot for an on-demand charter company that did not get passenger and baggage weights found that his airplane was uncontrollable shortly after leaving the ground. It began oscillations of increasing magnitude until it hit the ground and collapsed the gear. The airplane was several hundred pounds over gross and loaded well aft of the aft CG limit.

A PC-12 pilot made his last mistake when he failed to deice his airplane after pulling it from a heated hangar and fueling it while snow was falling. Witnesses said all of the upper surfaces were covered in slush. Shortly after takeoff the aircraft started a left turn and descended into the ground.

There were two accidents involving engine power losses. One PC-12 was damaged when the pilot hit the tail on the runway while making a go-around from a flaps-up landing approach. A pilot shot a second ILS to a wet runway, touched down with 1000 feet left and was unable to get stopped.

We found only two runway loss of control accidents, an indication of good ground handling.

One PC-12 hit an elk on landing, another hit a deer. While it may seem insignificant, that's a high rate and a risk worth considering when going into smaller airports.

to the King Air 200 series—a workhorse of general aviation. One look at the PC-12 and it's obvious that it was designed as a workhorse, too. Moreover, it's similar in size and performance, but with a substantial operational cost savings with one engine.

At 5 feet wide with nearly 5 feet of headroom, the PC-12's cabin is slightly larger than a King Air 200, with the extra width noticeable once inside. The seats recline and swivel and have three-point restraints. There's also a potty opposite the airstair door, with its own solid door for privacy. Removing and reinstalling the interior in this aircraft—like many higher-end cabins—is a lot of work that you'll pay for during avionics upgrades.

Need to transport your small motorcycle or power equipment? No problem in a Pilatus thanks to its 53- by 52-inch aft cargo door. It's hinged to open vertically hydraulically, although it closes via an electric motor and can also be operated manually. The latching mechanism for it and the main cabin door is easy to operate and the telltales showing the position of the latching pins were obvious and easy to read. A forklift can approach the fuselage at a 90-degree angle. The cockpit is comfortable for virtually any size pilot. The step past the console is not particularly difficult and while we would prefer a side stick from a crashworthiness perspective, the control yoke slides out of the panel so there's no column to take up floor space. The crew seats adjust vertically and horizontally, tilt, have lumbar support and four-point restraints. One unusual feature in an airplane this size is adjustable rudder pedals, which allow the pilot to obtain the eye position recommended by lining up two small balls on top of the magnetic compass.

The PC-12 has an all-electric trim system, controlled via a toggle on each control yoke. Power control is single-lever, just like a jet, with no manual RPM control. Starting a PC-12 is conventional for a turboprop. Hit the starter button, then introduce fuel at about 14 percent RPM and monitor to assure the start stays within temperature parameters. Once the Pratt is running, the

two generators and avionics master switches are turned on and it's time to taxi.

Once off the runway (with a 2650-foot takeoff distance at max weight), the PC-12 can climb at 1920 FPM. With the prop in beta, landing distance over a 50-foot obstacle is 1830 feet.

PC-12NG

Clearly the more desirable of the used PC-12 models, the PC-12NG (for next-gen) was certified back in 2008 and it has the Honeywell Primus Apex glass cockpit. This is a well-integrated suite with engine monitoring, aircraft configuration, pressurization and environmental controls. While it's quite capable, the Apex might seem dated to some since it doesn't have touchscreen displays or synthetic vision—something Garmin has as standard in the G3000 suite standard on current competing turboprops. The G3000 will be front and center in Textron's Cessna Denali turboprop single, which will compete directly with the PC-12NG.

The Apex does have a cursor control device (CCD), but it was an option on many PC-12NGs. It has a trackball, scroll wheel and buttons for making selections on the two large multifunction displays. The CCD is perfectly mounted in the center pedestal area, aft of the power lever. Every time we fly an Apex-equipped PC-12NG, we walk away certain that pilots either transitioning from older PC-12s or from other aircraft will require healthy amounts of transition training to nail the Apex feature set. It's an integral part of transition training at Flight Safety International.

As one owner put it, "You need to be able to operate the Apex suite in preprogram mode—that is, without really thinking about what you're doing. It's not difficult, it's just different."

But saying that, the NG simplifies cockpit chores and includes a digital dual-zone Environmental Control System (ECS) for increased cockpit and cabin comfort, a fully automatic digital Cabin Pressurization Control System that requires no input from the pilot and a redundant Power Generation and Distribution System. The integrated nature of the Apex means lots of small conveniences, too.

For instance, prior to engine start, the backup battery powers one MFD so you can input a flight plan, look at weather graphics from the XMWX satellite system and get a clearance from the secondary comm radio, to name a few chores. But the PC-12NG offers more than new avionics. There's a dual electrical bus and a big upgrade on the powerplant.

That increased performance comes from the PT6A-67P, which delivers 15 percent more thermodynamic power for faster climbs (the full 1200 SHP can be maintained to a much higher altitude) and better cruise speeds by utilizing single-crystal CT blades and a new compressor configuration. This boosts the max cruise speed to 280 knots from 270 knots, which is reflected in a slightly higher fuel burn, although range is minimally affected.

Maximum operating altitude is 30,000 feet, although owners tell us that going above FL280 is rarely worthwhile from a fuel burn perspective. Plan on burning 360 pounds, or 54 GPH on average.

FEEDING IT

Several operators we spoke with estimate hourly operating costs at around $800, depending on fuel and ancillary costs. When operated under FAR Part 91, annual inspections are required, but Pilatus shops suggest 100-hour inspections for heavy usage. We're told that a typical annual inspection could easily run $15,000 on a low-time model. As for the PT6A-67B engine on the PC-12, it has a 3500-hour TBO and *Aircraft Bluebook* says the average overhaul cost is $350,000, but we think that's on the low side. As we have found, there are too many variables to nail across-the-board prices.

A hot section inspection (plan on $50,000) is generally recommended at 1750 hours, and 2000 hours maximum. The propeller has a 4000-hour or six-year TBO. Buy a newer PC-12 and the airframe could still be under the seven-year, 5000-hour transferrable warranty, while the engine is covered for five years or 2500 hours. In our view, if you have to ask what

A tech at Prostar Aviation in New Hampshire tends to the Pratt PT6A in a Pilatus on the maintenance floor. The Pilatus service center network is vast and owners we talked with are happy with a high level of service. Two forward access compartments outside the pressure bulkhead, bottom, provide easy access to systems during preflight. Trailing link landing gear, bottom, has 14 inches of travel for off-airport landings.

stuff costs to maintain on a PC-12—or any turbine-powered aircraft—you'll be shocked when the invoices roll in. Don't forget the cost and effort for training.

As owner-flown PC-12NG pilots reported—especially in a hardened insurance market—underwriters will require solid PC-12 initial and recurrent training before issuing a policy, which could likely include flying with a mentor pilot highly experienced in the PC-12. This isn't uncommon in the turboprop and jet world. Even then, insurance rates will be all over the board.

Aviation Consumer's insurance editor Jonathan Doolittle from Hartford, Connecticut-based Sutton James Insurance told us underwriters look favorably at PC-12 pilots stepping up from faster and more complex aircraft. That makes sense.

"Underwriters in general are looking for prior experience in anything that will make the pilot more suited to the airplane. I wouldn't recommend to someone that they go out and buy a Beech Baron twin, for example, to build some time before getting a Pilatus PC-12, but an underwriter looking at someone with time in a heavier, busier airplane will probably give him or her a little better deal on a premium," Doolittle said. He also noted that while underwriters each have their own ways of weighting different types of experience, in general anything that will make the pilot more suited to flying the PC-12—or any other step-up turboprop or jet—will help with higher limits and lower premiums.

A good place to start when considering stepping up to a Pilatus is POPA, for the Pilatus Owners and Pilot's Association. POPA holds an annual convention, offers training courses and is a solid source of knowledge when it comes to owning and operating a Pilatus.

Our go-to (and the one who offered his tech advice to this review) is Pilatus instructor John Braun. He's at john@westernaerogroup.com. He can help with training and advice

on the step-up decision.

FEEDBACK

Our shop, Prostar Aviation in Londonderry, New Hampshire, has been a factory-authorized Pilatus center since 2009 and we see a lot of PC-12s of all vintages. I think the PC-12 is one of the finest business aircraft ever produced. The aircraft continues to evolve and the company utilizes the latest in advanced technologies. In essence this turboprop offers class-leading capability with incredible reliability and safety.

The Pilatus Aircraft company in Switzerland enjoys a reputation for employing the most modern design techniques, precision engineering and cutting-edge manufacturing processes to produce its aircraft. The PC-12NG integrates a single turboprop engine into an aerodynamically advanced airframe.

It's become the world's best-selling business turboprop mainly because it combines excellent economy, reliability and versatility with inherent safety proven over the last 20 years. Today the fleet is over 1600 aircraft in global operation.

We see that transitions from smaller piston airplanes are common and the PC-12 has proven to be a viable route for many owners of Cirrus, Bonanza and Malibu airplanes.

In fact, a sizable percentage of new buyers come from Cirrus ownership. The PC-12 is a relatively simple airplane to fly despite its size and complexity.

Although the Pilatus is significantly bigger and more capable than a Cirrus SR22, it is still a single-engine aircraft governed by the same Part 23 certification. Think about the following: The PC-12 has similar approach speeds to the SR22, and to clear a 50-foot obstacle, the PC-12 at max weight requires an 1830-foot landing distance versus 2344 feet for the SR22.

The PC-12 can fly from Aspen, Colorado, to Teterboro, New Jersey, nonstop, and Boston, Massachusetts to the Bahamas nonstop. That's over 1570 NM range.

That's the angle-of-attack vane on the wing's leading edge of a PC-12NG.

Michael Kenny
Prostar Aviation

I have been piloting PC-12s for over 20 years—both early-gen and later PC-12NG models. My advice to potential buyers is simple: Keep with the recurrent (and get initial) training. These can be relatively east step-up airplanes, but only with the right approach. Even with my experience I frequent Flight Safety because it's a must to maintain proficiency.

Steve Hanschel
via email

I have been flying the PC-12 for over 15 years, from legacy PC-12s as early as the second PC-12 ever built all the way through to the latest NGs being delivered today. While there have been continual incremental improvements each model year, the core PC-12 remains the same; from the first to the newest models, they all deliver unmatched efficiency, performance and mission capabilities, bulletproof reliability, system redundancy and a level of safety by design that make this the ultimate owner-flown airplane.

I have mentored many pilots of all experience levels over the years in the PC-12 and the transition for all is typically seamless after the usual familiarization and practice. It is one of the best single-pilot

Used PC-12

(continued from page 31)

platforms for sure, and with the abundance of power, the ability to climb quickly above weather and no mixture/engine management to worry about, pilots quickly realize that it is a lot easier to fly than the light recip singles that they have been flying.

Controllers love the PC-12's ability to operate at speeds in the approach and airport environments from 80 knots to 180 knots. This makes it versatile in busier airspaces, like JFK for example, where we often arrive VFR and are able to fit into the arrival flows at whatever speed is required all the way to the FAF.

One of the most important things to note about the PC-12 is that is develops its best true airspeed at relatively low altitudes as compared to other turboprops. We often fly the northeast corridor and beyond 17,500 feet, which gives us a 265-knot speed and saves a lot of extra time by avoiding circuitous IFR routing and ATC delays.

The PC-12's runway performance is unmatched. In Nantucket, Massachusetts (KACK), for example, we often land on taxiway/runway 30 to hold short of runway 6/24 when there is heavy traffic going in and out of KACK. It also allows for takeoffs with plenty of margin on other runways that may not be the preferred runway for winds.

I recently departed KACK on a busy weekend with new owners in the airplane. The lineup for runway 24 was planes deep on the taxiway on a CAVU day. The winds were a quartering crosswind for runway 15, and was not being used, but not noted as closed on the ATIS. I simply requested it and we were airborne within a minute and landed on the mainland 10 minutes later, dropping the pax off, while many holding short in the line were likely still in the cue. I relayed to the owner that this was exactly why he bought the PC-12.

While there is no one perfect plane for every mission, the PC-12 would be the plane I would choose if I had to pick only one. It doesn't do jet speeds, but the comfortable cabin, the low operating costs and low fuel burn make the extra hour or so to Florida from the Northeast worth it. The ability to land on unimproved strips as short as 2000 feet make it the ultimate touring platform and opens up so many more airports.

The range at altitude is remarkable and it will easily stay aloft 6-plus hours without pulling the power back. I have flown 8-plus-hour legs on several occasions on deliveries abroad with ample reserves at the landing.

Nonstops from the mountain states to the East Coast have always been nonstop for me and typically take about 5 to 5.5 hours.

Westbound typically requires a fuel stop. If the winds are very strong at altitude, we will often fly at lower VFR altitudes to get out of the wind and make far better time. Though we burn a bit more fuel, (maybe 500 to 550 PPH, versus 380 to 400 pounds or so) the net gain in speed and time savings makes it worth it.

The Honeywell Apex avionics system in the NG with synthetic vision is one of the best platforms to fly low approaches and the redundant situational awareness is helpful, but you need to be proficient with it all.

Many pilots who are transitioning from Garmin panels (especially the G1000) have hesitations about learning a new system—including the different FMS— but that usually disappears pretty quickly once they learn the keystrokes and system logic.

You get the idea why Pilatus has enjoyed such success with the PC-12.

Peter Simpson
via email

PIPER SENECA

It's time to take a look at the used Piper Seneca market for the *Aviation Consumer* Used Aircraft Guide. We want to know what it's like to own these twins, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your Seneca to appear in the magazine, send us any photographs (full-size, **high-resolution**) you'd like to share to the email below. We welcome information on mods, support organizations or any other comments. Send correspondence on the Seneca by October 10, 2019, to:

Aviation Consumer
e-mail at:
ConsumerEditor@hotmail.com