Angle of Attack: Now Available for Everyone

By Aviation Consumer , Staff Report | January 4, 2013

As long as you don't require flap-position sensing, an AoA system is a minor alteration. But the FAA may relent on more integrated systems soon.

We're told that somewhere there's an Israeli air tactics manual that contains the line, "Speed is life." Good thinking for fighter pilots, but down here in the more mundane world of GA, it's probably more appropriate to say, "Angle of attack is life."

AoA sensors in GA airplanes are as rare as $4 avgas, so we use airspeed as a proxy to get the right angle for approach and landing. One problem with airspeed is that most of us only know the right airspeed for gross weight at sea level on a standard day. If we're light, we tend to come in fast and curse the floating landing that ensues. The other end of the problem is getting too slow, or pulling the plane into a high-g-loading stall far above the wings-level stalling speed. The result when at low altitude can be grisly.

Oddly, there have been at least four companies offering reasonably priced AoA detectors for over 15 years. They're flying in experimental aircraft and plenty of certified birds. Some new interest from the FAA in the safety payoff of AoA indicators may shake things up, even though there hasn't been a policy change yet.

Alpha Systems

Mark Korin is president of Depot Star, Inc., which operates Alpha Systems to manufacture and sell a wide range of AoA systems. He's not certain how many of his systems are flying in aircraft, but he's confident it's over 3000—about 40 percent of which are in certified aircraft as sophisticated as King Airs.

In December of last year, Alpha received a letter from the FAA stating unequivocally that their system is a minor alteration and can be installed by any willing A&P without STC or 337 form. It's

just a logbook entry. This isn't new policy, so much as clarification so no overzealous FSDO demands a field approval. A copy of the letter accompanies any kit you purchase.

Alpha doesn't measure AoA directly. Instead, a probe is mounted at least two feet outside any prop tip and at least six inches behind a wing leading edge. The probe is similar to a pitot tube in that it measures pressure at two points. As AoA changes, these relative pressures change and a relative AoA is computed. Once calibrated, the system can display your relative AoA compared to "optimum alpha," which is essentially L/Dmax, or your maximum lift potential. (Please no detailed aeronautics letters on this. It's close enough that it works.)

The probe typically mounts in an inspection cover, and the kit comes with a blank to cut and fit for your aircraft. There are also pre-made plates for common sized openings. From the probe, two pneumatic lines run to a transducer, which connects to a cockpit display. Alpha offers these in round, horizontal or vertical presentations that can be mounted in the panel or up on the glareshield to keep them in view during landing. Korin says the glareshield is the most popular option.

Optimum alpha shows as a blue LED. Fly at a lower (safer) angle that that, and you'll see yellow or green lights that can completely extinguish during cruise if you wish. Fly below optimum alpha (higher AoA) and you get red lights, as well as an auditory warning if you tie the system to your audio panel. There are multiple options for how you prefer the light and audio warnings. For those who don't have an electrical system, or don't want AoA to rely on ship's power, there's a purely mechanical option with a needle gauge. You'll forgo any flashing or spoken warnings, however.

The electrical system is also easier to calibrate. Once installed, you push a button while the aircraft is stationary to get a baseline. Once in the air, you'll fly at low RPM and the highest pitch you can maintain that holds level flight—that is, any increase or decrease in AoA yields a descent. If done correctly, this is optimum Alpha regardless of airspeed or power. A final set point is made at cruise. The mechanical system must be flight-tested several times, adjusting the probe angle with each flight to match the correct needle position with optimum alpha in flight.

From there on, you'll see exactly where you sit relative to optimum alpha, which is also roughly 1.3Vs, the ideal approach speed automatically corrected for your current weight, density altitude and so on.

Well, almost. Aircraft with flaps approach at 1.3Vso—flaps out—not 1.3 Vs. The Alpha system earns its minor mod status because it doesn't tie in to the flap system. This means it reads incorrectly with flaps extended. Korin says this is a non-issue because flying at optimum alpha per the gauge means you have a buffer over the flap-out optimum. You can also correct mentally. Fly at the same low-speed, high-angle, no-sink you did during calibration but with flaps out and note how many LEDs into the red you are. This is optimum alpha with flaps extended. It will vary aircraft to aircraft, but always be the same for a given plane.

The Alpha system ranges from $700-$1300, depending on your display, audio and mounting choices. A heated probe is an extra $125. Pressurized-aircraft kits start at $2000, and dual-display options for two-pilot cockpits are available. Korin also tells us that the technology to incorporate flap position is there, if the FAA ever lightens up on it. He also says he's in some product discussions he can't disclose just yet. Perhaps an option to display AoA directly on the PFDs of equipped aircraft? We wouldn't be surprised.

Advanced Flight Systems

Rob Hickman's company, Advanced Flight Systems, is a top name in the experimental and LSA world for EFIS (glass-panels). They also make standalone AoA systems, although only a few are in certified mounts. These owners have 337s, and the accompanying scars from battling their local FSDO. Advanced's system also uses differential pressure, but with two .04-inch holes in the wing at about 20-percent wing cord. These also run to a transducer and can be displayed on a simple, eight-LED bar (Sport model), a sharp LED display with both relative angle and a digital readout of actual angle (Pro model), or directly to one of their PFDs. Hickman says that about 70 percent of their EFIS buyer opt for AoA. "It's a very popular option."

As with the Alpha system, lights extinguish in cruise and illuminate as angle increases. Get past 15 degrees nose up and an audio callout says, "Angle. Angle. Push."

Advanced has a flap sensor, so you calibrate it for both a clean and an approach flap setting. The display then corrects AoA automatically with flap extension. Hickman says that once flaps extend past an approach setting, the resulting AoA change is minimal in most cases. The Pro system also has a gear-warning system built in.

Flap integration makes certification trickier, but Hickman says they are pursuing it with the increased interest in AoA. Hickman told us there are some systems out there in 182s, Caravans and Bonanzas, but "We don't exactly know [how many] as customers try and keep it quiet."

The Advanced system is $1490 for the Pro system and $890 for the Sport. Adding it to their EFIS is $790.

RiteAngle

Elbie Mendenhal is a retired airline captain and takes the pivoting vane approach to measuring AoA as used on most airliners. While his RiteAngle system looks like it's measuring actual AoA, it's really relative AoA dependent on a calibration flight. RiteAngle can correct for up to five separate flap positions and, according to Mendenhal, can handle speeds up to .78 mach.

The vane must be mounted in clean air, which means the nose on pushers or twins and at least 13 percent of chord length below any wing. That works out to about seven inches on an RV, but a full foot on a PC-12.

Can you mount it on a PC-12? Well, someone did, but had to take it off when the feds found out. Flap integration was again the issue. RiteAngle has a couple of legitimate (if unusual) STCs, including the Helio Stallion and the Cessna 421. Unfortunately, the original paperwork on the 421 was lost and there's only one flying. There are also a few successful 337s.

Cockpit display for the RiteAngle is a simple LED bar, with the warning lights set for five percent under 1.3 Vs for the current flap position. There's a connection for an external buzzer or audio panel integration. The company website shows four products, but really only two apply to GA. The Buddy system is $400 and has no flap sensor or correction (and is more likely to succeed on a 337). The Elite system is $750 with the flap sensor.

Mendenhal told us he has a system he hopes to get FAA certification for that uses noninvasive ways of sensing both manual and electric flaps. He hopes this will be ready at Oshkosh and will retail for under $1500. Given the history with the FAA on this, we'll reserve comment until we see that complete.

InAir's LRI

InAir's Lift Reserve Indicator (LRI) was one of the first AoA options on the market, and is largely similar to Alpha's mechanical system, with a mechanical indicator and no flap position correction. While this basic system hasn't evolved much since its creation, its price of $450 makes it a relative bargain.

InAir's owner, Al Mojzisik, tells us he's had a letter from the FAA similar to Alpha for over 10 years, so this system is a minor alteration. He adds that he'll refund any system that gets a kibosh from the local FSDO.

Tangible benefits

We said it back in 2008 when we last examined these products and we'll say it again: It's surprising that there are so many options for what seems like such an esoteric product. Given the options and the fact that it can be a minor install, it's also somewhat surprising that it's not more common. We've heard that an ASTM is in the works for AoA systems. We couldn't find out details by publication time, but this could help pave the way for more integrated systems in certified aircraft.

For certified aircraft, we like what Alpha Systems is offering. The kits are complete and appear to be well-supported. The standard-sized inspection cover mounts and instrument-hole options should make for a simpler install. We also like that the logic in the transducer may allow for flap integration at a later date. For simply a mechanical system, InAir is cheaper, but their gauge won't fit a standard instrument hole if you don't want it on the glareshield.

For LSAs and experimentals, our nod is to Advanced's Pro system for its combination of low-profile installation, a great display and flap/gear integration.

Is the system worth the expense? We think so. There's more to look at here than just some extra protection against becoming a stall-spin statistic or floating a bit on landing—although that may be enough for many pilots.

We had an LRI system in a Mooney for years and routinely had approach speeds lightly loaded that were under stall by the airspeed but with plenty of lift in the bag. Every landing at the right speed and descent rate is that much less wear and tear on brakes, tires and landing gear. If you spend some time, you can get just the right angles for best rate or best angle of climb as well. That's all for an investment of under $1500 for most light aircraft. We think that's a pretty good deal.