

Alpha Systems Lift Reserve Indicator

You Have to Slow Down to Get Down

text & photos by Sparky Imeson

I fly air taxi in a Cessna 180 throughout the northwestern Rocky Mountain region, and many of my destinations are short strips at high altitudes with challenging approaches. Though I often set and maintain a given aircraft attitude for short-field approaches, cross-checked by the airspeed indicator, the true indication of how close an aircraft is to a stall is really the angle of attack. In my previous career, I flew a Citation X for 2,000 hours and learned firsthand the value of an angle of attack (AOA) indicator. So when I received an Alpha Systems AOA for Christmas from my friend Gary McDonald, I was anxious to go out and play with this new toy.

The Citation X has a true angle-of-attack indicator developed by Leonard Greener of Safe Flight Instrument Corp. It is invaluable in providing the speed to fly under various conditions, especially in a wind shear situation. It is much better than waiting for the stick pusher activation that occurs automatically when the airplane is close to stalling. However, there is no way to justify the cost of this AOA indicator in a light single-engine airplane.

Morgan Gurdon Huntington developed an alternative, more economical method that indirectly calculates the angle of attack by measuring differential pressure at two locations. The not-quite-two-pound Alpha Systems AOA system indicates "lift reserve" on a gauge in the cockpit. Since it uses a probe that is similar to a blade-type pitot tube with a forward and aft port, it is more correctly called a pressure-differential indicator. From my point of view, it is an affordable angle-of-attack indicator because differential pressure equates proportionally to angle of attack.

Above: Landing at the 1,770-ft.-long Kiles Air Strip (MT43) southwest of Helena, Mont., at 6,300 ft. elevation requires precision.

My 1975 Cessna 180J has been modified with the Sportsman STOL leading edge cuff and Micro Aerodynamics vortex generators. It stalls around 45 mph indicated airspeed when operating at light weights and around 86 mph indicated in a 60-degree bank at gross weight. Regardless of the flight condition, the wing always stalls at the same angle of attack. The short-field approach airspeed must be flown with a buffer between the stall speed and the approach speed to provide sufficient air control to flare and complete the landing. The amount of buffer is a function of pilot skill and prevailing conditions (especially gusts/turbulence). Some pilots are proficient and have that warm, fuzzy feeling when flying at 1.1 V_{SO}, while others

will fly at 1.3 V_{SO}, which is probably okay if there is a long runway available. In any case, the buffer is really a "lift reserve," that is more important than adding "X" mph to the stall speed. If you adjust your flying to always approach at a given lift reserve, you will be able to consistently fly a short-field approach with predictable performance, eliminating the float during the flare, each and every time, regardless of the weight of the airplane, the center of gravity, the flap setting, or the density altitude. An approach during turbulent, gusty conditions will cause the indicated airspeed to jump around. Rather than watching the airspeed vary, you can see the lift reserve change, and this gives a better indication of how close to the edge you are flying.



Installation

The Alpha Systems installation manual calls for four to twelve hours for the complete install. My Cessna 180 installation was completed in a little over two hours. The only time consuming part was stringing two 1/8-inch hard plastic tubes

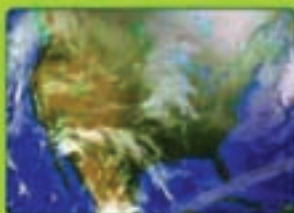
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(and a 14-gauge wire for the later installation of a heating element) from the probe in the outer wing to the cockpit area.

The calibration did not require any complex steps or special equipment; it just required flying. The blade is initially adjusted to a 50-degree angle. Calibration is then done in flight by transitioning to slow flight at minimum controllable airspeed until the vertical speed indicator shows a zero rate of climb or descent. The object of this exercise is to have the needle align on the mark between the red and white arcs. This determines what is called the "Zero Lift Reserve." If the needle is too far in the white, move the probe forward about one degree for each increment it is off; if it's too far in the red, move the probe aft. One or two flights should be all that you need to get the instrument calibrated.

Using the Indicator

The AOA indicator is divided into three arcs: the red arc to show danger or at least caution, the white arc for maneuvering, and the green arc that Alpha Systems calls an area with "buckets of lift."

The juncture of the red and white arcs on the Alpha Systems AOA represents the L/D_{MAX} and is the "zero lift reserve" datum used for calibration. This provides the best angle-of-climb speed regardless of the plane's gross weight and center of gravity, the flap setting (at least on the Cessna 180), or the density altitude. It functions during banked flight or forward slips, and it is more stable than the airspeed indicator when operating in turbulence or gusty wind conditions. Flying this point after an engine failure will provide the maximum glide speed. When this speed has been determined for the existing flying conditions, multiply it by 76% to obtain the maximum endurance speed, which is also the minimum sink speed (point B on the Drag Curve diagram).

The red arc of the AOA is known as the "area of reverse command" or the "backside of the power curve." An unsuspecting pilot may encounter problems when operating here. If you increase the angle of attack beyond L/D_{MAX} , you operate in the red zone and the airplane's wings are unable to generate sufficient lift to maintain level flight. An increase in angle of attack or reduction in power without lowering the nose will cause the airplane to begin to sink. Moving farther into the red arc causes the mush or burble associated with the stall, then

Point A is the maximum lift coefficient right before stall; Point B, 76% of L/D_{MAX} , represents the minimum sink speed; Point C is L/D_{MAX} .

the stall itself. The amount that the needle moves into the red zone depends on the make and model of aircraft. The Cessna wing will allow the needle to move lower into this arc before stalling than some other airplanes. Also, the application of flaps may change this indication since you are effectively changing the chord of the wing.

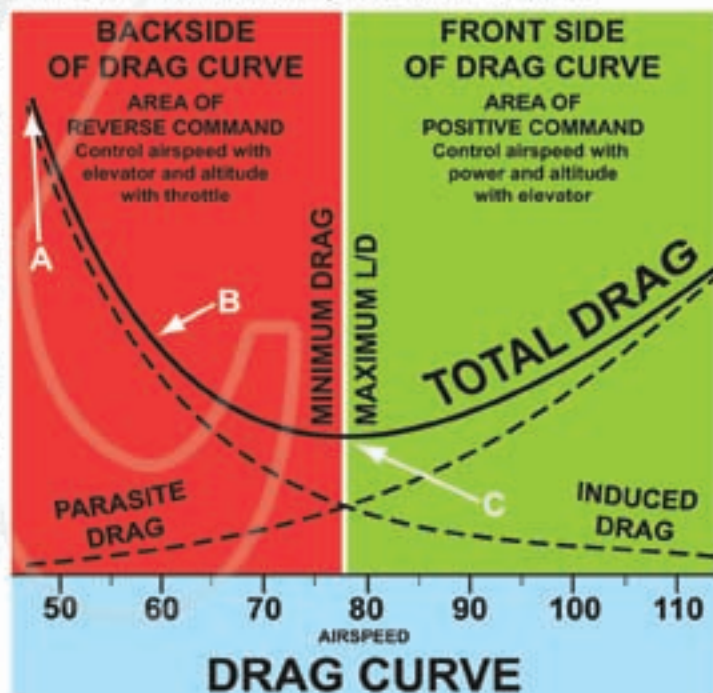
The white arc is the maneuvering area. Making a short-field approach to landing with the needle indicating in the lower white arc range means there will be insufficient inertia remaining to cause floating after the transition from the approach attitude to the landing attitude. This guarantees the shortest landing distance. Using the spot method for landing—that is using an aiming point on the airstrip—and maintaining an airspeed in the white arc will consistently result in a touchdown within about 50 feet of the aiming point. The juncture of the white and green arcs is where you obtain the best rate-of-climb speed.

The needle indicates in the green arc during normal flight.

A chart of the drag curve shows the total drag is comprised of parasite drag from air friction, and induced drag resulting from lift being produced. Induced drag varies inversely with the square of the airspeed. If the speed is cut in half, the induced drag quadruples. This is the opposite of the creation of parasite drag, which varies proportionally to the square of the airspeed.

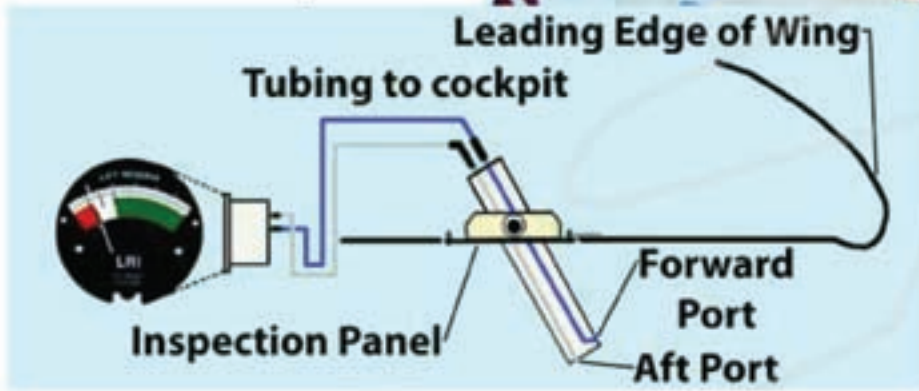
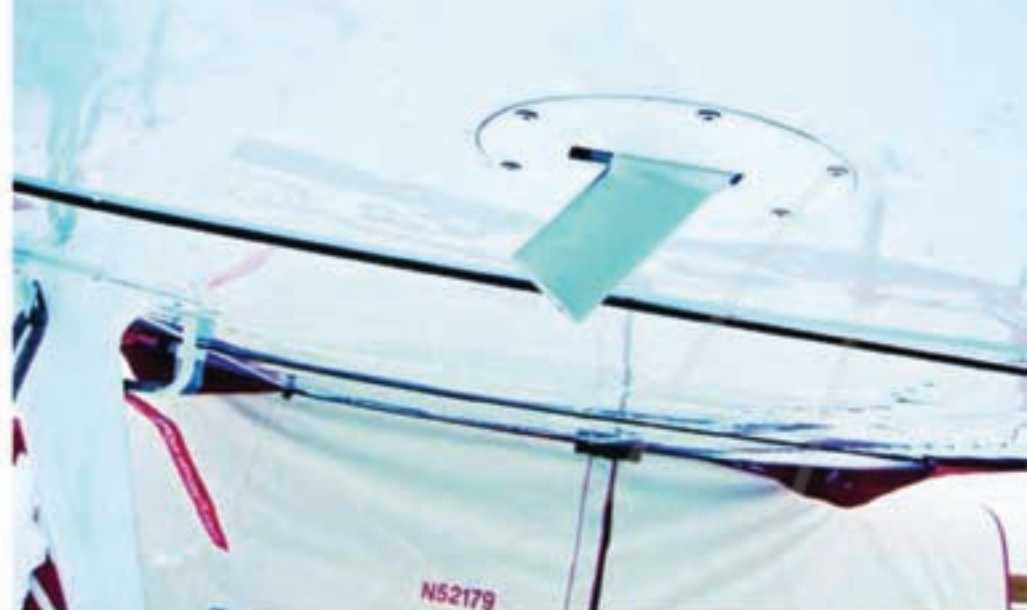
Suppose the pilot of a Cessna 180 on approach to an airstrip sees he is below the desired glide path. The first reaction is to pull back on the control wheel to extend the glide. When operating on the backside of the drag curve, this does not arrest the rate of descent; rather, it increases the sink.

The correct response goes against your grain; you need to lower the nose slightly and increase the power. On the "backside,"



It is important to pitch to airspeed and power to altitude (or rate of descent). If power is unavailable (such as after an engine failure or in a sailplane), you must lower the nose to increase the airspeed and reduce the rate of descent.

Assume the pilot did not make the correct response and continues to approach the runway with the airspeed too slow and with the increased sink rate. Upon arrival at the flare point, the wing is unable to generate sufficient lift, and the pilot, working with a limited amount of elevator movement, finds that when he pulls back on the control wheel, the nose does not come up and the descent is not arrested. Under this circumstance, there is not enough power available, even with full throttle, to stop the sink and make a safe landing.



Installation of the Alpha Systems AOA is simple: mount the probe in a wing panel, string tubing from the probe to the cockpit, and mount the indicator.

I'd like to think that with nearly 20,000 hours of flight time that I can jump into any airplane and "feel" the speed to use for a short-field landing. That doesn't happen.

In an unfamiliar airplane, I used to determine the minimum speed-to-fly for a short backcountry airstrip, based on the current weight and CG, by stalling the airplane. By slowly decreasing the airspeed with the power off in landing configuration until the stall, you will obtain the airspeed to which you add 10 to 15 percent for the indicated "over-the-fence" speed. It may be necessary to repeat this process after flying for awhile upon arrival at another short strip, since the weight of the airplane changes with the fuel burn, which, in turn, changes the stall speed.

Using the Owner's Manual or Pilots Operating Handbook to determine the exact approach speed for the short-field landing doesn't seem to work. Aircraft manufacturers, because of the real possibility of litigation, pad the numbers to prevent a pilot from getting too slow. I guess they don't realize that this could conceivably lead to litigation "in the reverse" since the airplane may float during the landing and, at a one-way strip, the only option available is to run off the runway.

Probably for the inexperienced pilot the AOA indication should be one or two increments above the zero lift reserve when conducting a short-field landing. After gaining experience and confidence, the approach may be flown at the bottom of the white arc, but be prepared to add power during the flare to make the elevator more effective.

The AOA is valuable during short-field takeoffs as well. Just before the needle rises toward the zero lift reserve, rotate the airplane. As soon as the needle indicates zero lift reserve, climb. This is the best angle-of-climb speed for whatever configuration of weight, center of gravity, flaps, and density altitude.

THE AIRPLANE TOUCHED THE RUNWAY LIKE A BUTTERFLY WITH SORE FEET AND STAYED FIRMLY ON THE GROUND. NO FLOAT, NO BOUNCE.

Flight Test Results

The AOA provides safety. It shows the proper indications with and without flaps extended for the best angle of climb, the best rate of climb, the minimum sink speed, and the maximum endurance speed.

How does it do this? The wing flies on angle of attack, not airspeed. To confirm that the instrument really works, I flew at zero lift reserve and performed a forward slip to the left. The needle moved about three increments into the red zone. The same occurred with a slip to the right.

At first I thought it might react similar to an airplane such as a Cessna 150 that has the static vent on only one side of the fuselage. Slip toward the static vent while maintaining the same glide attitude and the indicated airspeed decreases about 10 knots, slip away from the vent and the indicated airspeed increases about 10 knots. But the AOA doesn't react in that manner. It actually shows that a forward slip in either direction is effective in reducing lift, resulting in an increased sink rate and indicating a lift reserve diminishing toward the red zone.

I was a little skeptical when I started my first approach using the AOA, flying at zero lift reserve. Although I was at a light weight, I was certain that I would run out of elevator control during the flare and encounter a bounce or at least a solid arrival, due to the low indicated airspeed on approach. It didn't happen. The airplane touched the runway like a butterfly with sore feet and stayed firmly on the ground. No float, no bounce. Adding 360 pounds of fuel, mechanic's tools, survival equipment, and other gear increased the weight about 500 pounds. The next approach at zero lift reserve resulted in a higher indicated airspeed on approach with sufficient elevator authority to flare without floating, and again the airplane was solidly on the ground.

There is a misconception about the FAA's recommended 1.3 V_{SO} short-field approach speed. This speed is used for maneuvering. It is not the speed to be used for the "over-the-fence" arrival. Those who have mistakenly used 1.3 V_{SO} find they can't get the plane down on the runway. So what is the proper speed?



**RATHER THAN WATCHING THE AIRSPEED VARY,
YOU CAN SEE THE LIFT RESERVE CHANGE, AND
THIS GIVES A BETTER INDICATION OF HOW
CLOSE TO THE EDGE YOU ARE FLYING.**

Is It Worth It?

The Alpha Systems AOA is a nifty gadget. It just sits there and does its job. No electrical power is required (except for electronic display units or optional probe heat). It allows you to approach at the minimum speed for backcountry operations without getting into trouble, and without putting

into force your background, education, knowledge, training, experience, exceptional piloting skills, and the often elusive "seat-of-the-pants" feel for your airplane. A mere glance at the instrument confirms immediately that you are extracting the maximum performance from the airplane, whether it be takeoff, maneuvering, or landing.

The majority of general aviation accidents occur during the takeoff and landing phases of flight, followed closely by maneuvering flight. An angle-of-attack indicator may go a long way in preventing these types of accidents. Airlines and corporate aircraft have had the angle-of-attack indicator available for years. Now general aviation has an affordable indicator. If you get into a tight spot, you have the maximum performance immediately available with a glance at the Alpha System AOA.

So what does the Alpha Systems AOA do? Everything an angle-of-attack indicator will do... at a fraction of the cost. The mechanical unit runs \$400 and is manufactured by DepotStar, Inc., Ramsey, Minn. It is marketed as the "Alpha Systems AOA," (303) 408-6899 or (877) 571-3770. www.alphasystemsaoa.com. ■

Born and raised in Jackson, Wyo., Sparky Ineson has been flying in the mountains since he began flying his father's J-3 Cub and Cessna 205 in 1966. He received the FAA Northwest Region's Flight Instructor of the Year award in 1974, 1979, and 1995, and is the author of 18 aviation books, including the Mountain Flying Bible. He has flown much of his nearly 20,000 hours in small airplanes in the mountains. Today, he provides mountain flying instruction and operates an air taxi service to major airports and out-of-the-way backcountry destinations in his Cessna 180.



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