



# Eagle Operations Manual



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# Eagle

**Eagle AOA Kit – DSTR-AOA-9600K**  
**Eagle Dual AOA Kit – DSTR-AOA-9600KDUAL**  
**Eagle Pressurized AOA Kit – DSTR-AOA-9600PK**  
**Eagle Dual Pressurized AOA Kit – DSTR-AOA-9600DPK**

## **OPERATIONS MANUAL**

**P# AOA-9610**

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# 1. CALIBRATION AND SETUP

## 1.1 Definitions:

**Angle of Attack (AOA)** is the difference between the airfoils chord line (a line from the leading edge to the trailing edge of the wing) and the relative wind (the inverse of the aircraft flight path).

**Coefficient of Lift ( $C_L$ )** is a relative measurement of an airfoil's lifting capabilities. High lift airfoils found on typical general aviation aircraft have a curved or cambered upper surface and a flat lower surface. Airfoils found on high performance aircraft will typically have a thinner symmetrical airfoil. The  $C_L$  in both airfoils will increase with angle of attack until the stalling angle ( $C_{Lmax}$ ) is reached, at which point the  $C_L$  drops off rapidly. A plot of  $C_L$  vs. angle of attack will typically show  $C_L$  increases in a straight line for both airfoils to  $C_{Lmax}$ . A key difference between the two airfoils would be that high performance airfoil will generally stall at a much lower angle of attack then the high lift airfoil.

A **Stall** is a reduction in the lift coefficient generated by an airfoil as angle of attack increases. This occurs when the critical angle of attack of the airfoil is exceeded. The critical angle of attack or **Critical Alpha Angle (CAA)** is typically about 15 degrees, but it may vary significantly depending on the airfoil design. The **CAA** is identified by the pilot once the AOA system is calibrated by the last **red segment** being lit.

**Optimum Alpha Angle (OAA)** is the term Alpha Systems identifies as a set point for calibration of the AOA system at a 30% safe margin above Stall. This set point is easily identified, in flight, as **1.3Vs** and is identified when the **blue doughnut** is illuminated.

**Cruise** is the term Alpha Systems identified when the last green LED is illuminated. This calibration set point is easily identified first from the POH of the aircraft and will be weight corrected **Va** (maneuvering speed). To be as accurate as possible, **Va** is gross weight adjusted and corrected for installation errors from the "air speed correction table" for that flight. The Alpha Systems AOA will have the **green segment** illuminated until the AOA begins to increase up the scale.

## 1.2 Restrictions and Limitations:

- This AOA system has not been determined to be suitable for installation in any specific aircraft by Alpha Systems. It may be installed in a type-certificated aircraft, provided that it has been determined suitable for installation by an appropriately rated mechanic by means such as field approval or as a minor alteration.
- Installation of the Alpha Systems AOA in a commuter or transport category airplane is prohibited, unless approval is given from the FAA.
- Installation of the Alpha Systems AOA as a replacement for or modification to an existing approved stall warning system is prohibited!
- The Alpha Systems AOA is required to have a placard located in plain view that must state the following: “Not for use as a primary instrument for flight.”
- The AOA system may not be used as a substitution for the certified aircraft stall warning system.
- No operational credit may be taken for such items as reduced approach speed and shorter landing distances.
- The Alpha Systems AOA is not required and is intended to provide supplemental information to the pilot.

**The Alpha Systems AOA cannot be placed in the cockpit in such a manner as to interfere with the pilot’s view of primary flight instruments.**

**The Alpha Systems AOA cannot be placed in the cockpit in such a manner as to obstruct the pilot’s view or cause distraction.**

**The Alpha Systems AOA is a stand-alone system and does not replace any existing, primary instruments, or displays and is not considered essential for flight.**

### 1.3 Theory of Operation:

Every aircraft, in flight, has an alpha range from **Stall** (highest alpha angle) to the **Cruise** angle of attack (lowest alpha angle). All pilots manage the appropriate amount of lift for the varying stages of flight, whether it's setting up to enter the pattern, downwind, base, final, short final, flaring to touch down or knowing when to climb, maneuver, bank and turn safely.

The Alpha Systems AOA measures Angle of Attack through a probe mounted solidly in a location that would sense undisturbed air at any aircraft Attitude, Pitch, Slip or Skid. **There are NO moving parts.** This AOA probe protrudes approximately 3.5" down from the surface of the mounting plate. The AOA probe has two sense holes BOTH measuring ram pressures. Both ram air sense ports are connected to an interface module (**IM**) through BLUE and a WHITE ¼" hoses. The electronics in the **IM** convert pressures to digital signals. The **IM** module also communicates with the display(s), aircraft audio panel for AOA warning messages and houses the system computer that controls the entire operational functionality.

The Alpha Systems AOA Angle of Attack system is designed, once calibrated, to correlate ultra-bright LED segments to indicate the entire range of lift, from no lift (**no segments on**), to the highest margin of lift above stall - the lowest Angle of Attack (**green bar on**). It does this using the principles and accuracies of an Angle of Attack (**AOA**) measurement system.

After calibration, a pilot can repeatedly have an indication of **Stall (Vs) to Optimum Alpha Angle (OAA, 1.3 Vs or 30% above Stall)** to the top of the Alpha Systems AOA scale at **Cruise** - calibrated at weight corrected **V<sub>a</sub>** (maneuvering speed). After these calibration set points are entered and stored, the AOA display will illuminate colored LED segments to indicate the angle of attack range from before **Stall (No LEDs on)** to **Cruise (Just the green segment on)**.

### 1.4 AOA Probe Angle and In-Flight Calibration Correlation:

The Alpha Systems Angle of Attack system displays **AOA / LIFT** measurement of the aircraft by means of an AOA probe that's mounted solidly to the aircraft. The AOA value consists of the AOA of the wing (**when in flight**) combined with the angle of the AOA probe to the chord of the wing measuring differential pressures derived throughout the entire flight envelope of the aircraft in which it's installed.

The electronics must see data within a given range to allow for a linear and full-scale reading. Due to the number of aircraft and other variables; stall angles, wing designs, coefficient of lift, mounting locations, and so on, **the probe angle will be initially set at an angle of 50 degrees to the chord of the wing. In most aircraft, starting angle would be derived from the bottom of the wing skin.**

During the calibration flight, the display will give direct feedback if the pressure values received from the AOA probe are outside the range to give a proper full scale display indication, the system will flash combinations of background segments; **RED + BLUE** (pressures too low), or **YELLOW + BLUE** (pressures too high) which will indicate the direction to tilt the probe.

## 1.5 Three Set-Point Calibration Overview:

The computer system forces the calibration steps to be completed in the following order:

**(Set-point 1) Zero-Offset Calibration:** On-the-ground, no pressure and no air flow at the AOA probe set-point. The Ground calibration wipes all values from the data base and stores a value of zero in the computer for a reference and self-check procedures. A valid **zero-offset** calibration must be entered before the computer will allow the in-flight procedures to be entered.

**(Set-point 2) Optimum Alpha Angle (OAA):** Indicated by the blue doughnut LED segments. Alpha Systems AOA defines the **(OAA)** set-point by: In the **CLEAN CONFIGURATION**, first flying to identify the true and actual **Stall** speed for the current weight, CG, passengers, and baggage. Then, multiply the identified **Stall** value, by **1.3 (Vs)**. With the AOA system in the **OAA** calibration mode, fly the aircraft at the **1.3 Vs (30% above Stall)**. Maintain airspeed and trim for straight and level flight. When set, the display feedback will correlate to the **OAA** Angle of Attack of your aircraft.

**(Set-point 3) Cruise:** Set-point is indicated by the green LED segment. To finish calibration, the set-point for the lowest angle of attack calibrated and displayed must be entered. After the **OAA** set point is flown and entered in the system, the in-flight **Cruise** set-point mode must be identified. This set-point is from the POH of the aircraft and will be **V<sub>a</sub>** (maneuvering speed) - gross weight adjusted and corrected for installation errors according to the "air speed correction table" for that flight. The aircraft is calibrated at a maneuvering speed (alpha). This set-point allows the system to display a range of LED segments from **Cruise (green)** to **OAA (1.3Vs, blue)** and up to **Stall (1.0Vs, red)**, or **Critical Alpha**.

**(Optional) Stall:** After setting a successful Cruise set-point, press the **SEL** button again to enter stall set-point calibration. In the clean configuration, fly 1.0Vs and press the **CAL** button.

Once the pilot has completed the calibration procedure, both **OAA** and **CRUISE**, the entire range of lift is displayed and can be used to identify angles of attack related to aircraft performance, such as: approach, **OAA**, **Cruise**, **Stall**, best glide and best climb, to name a few. Once identified by the corresponding LED segments, these angles may be used accurately at any weight or density altitude, CG and bank angle every time.

## 1.6 Flap Calibration Overview:

Once the system has been successfully calibrated in the "CLEAN" configuration of BOTH **OAA** and the **CRUISE** values, and **STORING** both values, the software will allow calibration of **up to 3** additional **OAA** flap calibrations. The system has one analog I/O input and 4 discreet inputs for flap sensing. The **flap OAA** calibration processes are identical to the clean configuration, fly or identify the weight adjusted stall speed for each wing configuration; Flap1, Flap2, Flap3, multiply each times 1.3. It is possible to connect a Flap0 input, if necessary. Flap0 represents flaps up.

## 1.7 Gear Warning Overview:

This function requires the installer to connect the Gear Warning input to the IO Module (DSTR-AOA-1970), which is part of the optional IO expansion kit. Once the system is calibrated and in its normal operating mode, pressing the SEL button at rotary position 3 will activate an audio warning saying, "Gear, Gear, Gear" when the pilot is approaching OAA with the display showing the Yellow Chevron. The unit will announce "Gear Warning On or Off" when the SEL button is pressed.

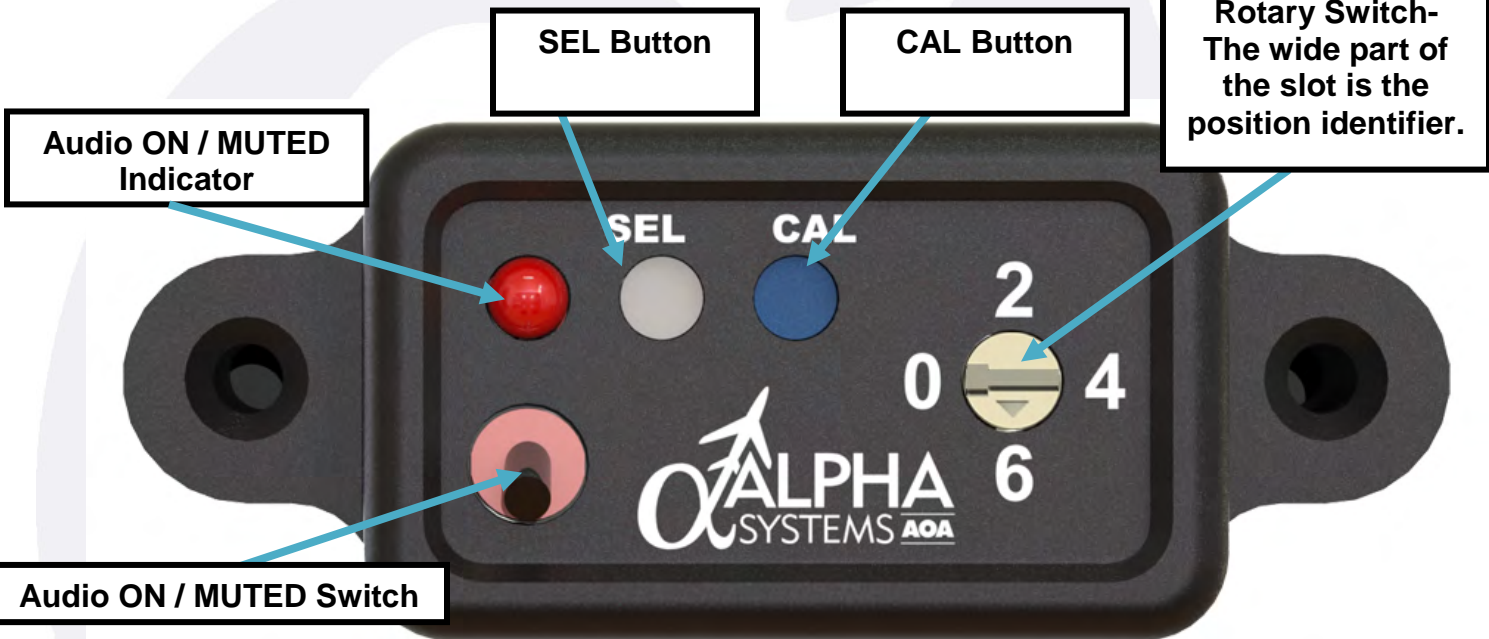


The Photocell will automatically adjust LED intensity by sampling ambient cockpit light levels and switch between two preset brightness levels.



The Eagle display has 9 highly visible, colored LED segments that will illuminate to indicate the available Lift throughout the AOA range of an aircraft, once calibrated.

The Brightness button, when pressed repeatedly, will increase the light level through 16 steps until its maximum then drops to the minimum level and repeats.



SEL Button

CAL Button

Rotary Switch- The wide part of the slot is the position identifier.

Audio ON / MUTED Indicator

Audio ON / MUTED Switch

The Eagle AOA system requires a remote switch panel that must be mounted in a location near the pilot for activation of the calibration procedures and turning the audio ON or OFF. It can be anywhere within the cabin and comes with a 6 foot extension cable.

## 1.8 Switch Definitions on the Remote Switch Panel

- 1.) **Audio Mute Switch:** Switch used for activation or deactivation of the AOA warnings to be heard through the aircraft's audio system. When in the UP position, audio warnings can be heard.
- 2.) **Audio Mute LED:** Amber colored LED indication of audio ON or MUTED.
  - a. **LED Illuminated** – Audio muted.
  - b. **LED OFF** – Audio ON.
- 3.) **SEL Button:** This button is used to enter the configuration modes when the rotary switch is in the corresponding mode set position.
- 4.) **CAL Button:** When directed in the Calibration procedure, the depression of this button enters (as in "saves to memory") the value sampled.
- 5.) **Rotary Switch:** An 8-position rotary switch that uses the **WIDE PART OF THE SLOT** as the identifier. There are markings on the case at **0,2,4,6** but can be positioned in-between to gain access to the **ODD** numbered mode procedures when directed in the calibration sequences.
  - a. **Position 1** – Eliminates previous set-points and enter **zero-offset** calibration.
  - b. **Position 2** – Enter **OAA** and **Cruise** set-point calibration. Power remains ON.
  - c. **Position 3** – Enter day/night brightness level calibration. Hold SEL, then power ON.
  - d. **Position 4** – Enter volume level calibration. CAL button increases volume level.
  - e. **Position 5** – Enter audio type calibration. CAL button cycles through audio choices.
  - f. **Position 7** – Enter flap diagnostics routine. Hold SEL, then power ON. No audio.
  - g. **Position 0** – Store OAA & Cruise settings, store flap settings.

*Note: When the Gear Warning is installed, pressing SEL at position 3 will activate/deactivate the audio warning as long as power is already applied to the system.*



## 1.9 (Set-Point 1) Zero Offset Calibration (Ground):

**VERIFY THAT THE AUDIO MUTE LED IS OFF TO BE ABLE TO HEAR THE CALIBRATION AUDIO INDICATIONS.**

The first calibration step after the system has been installed and all of the electrical connections are made is to verify electrical and zero-pressure set-points. When the unit is first turned on and all of the LED's flash, signals that the AOA must have the **Ground** calibration procedure completed.

**ATTENTION:** *The ground calibration set-point can be reset at any time after the initial calibration. However, ALL in-flight set points will be reset and therefore must be re-entered.*

**Zero Offset calibration (Ground)** is the on-the-ground, no pressure and no air flow at the AOA probe set-point. The **Ground** calibration wipes **ALL** values from the database and stores a value of zero in the computer for a reference and self-check procedures. A valid **Ground** set-point must be entered before the computer will let the in-flight calibration start.

Follow these steps to complete the **Zero Offset Calibration (Ground)**:

- 1.) Turn the **Rotary Switch** to **position 1** with a small screw driver. The wide part of the slot should be pointing between 0 and 2.
- 2.) **With power OFF**, hold the **SEL button down (white button)** and power the AOA system **ON**. The AOA computer, through the aircraft's audio panel, will announce "**Set Zero Offset.**" All segments on the display will be flashing **ON and OFF** indicating the **Zero Offset** needs to be calibrated.
- 3.) Press and hold the **CAL button (blue button)** down.

**ATTENTION:** *You must complete this step to retain a zero offset set-point. Failure to press the CAL button before powering OFF, and then ON, will cause the system to revert to previous settings.*

- A.) If the **Zero Offset** set-point is accepted, the unit will announce "**Zero Offset Complete**" and will flash the **blue and the green background segments** 5 times to indicate that the ground calibration was successful and in-flight set-points can now be flown and entered.
- B.) If the **Zero Offset** set-point is not accepted, the display will continue to flash ALL SEGMENTS, and the unit will announce "**Invalid Zero Offset**".

## Failure to Complete Zero Offset Calibration

If the AOA continues to annunciate "**Invalid Set-Point**" when the **CAL** button is pushed, the zero pressure value from the sensor is too high. This indicates something is wrong electrically or mechanically with the system, or something in the environment is affecting the system. The electronics of the system will flag the bad zero offset by flashing ALL segments until an acceptable **Zero Offset** set-point is entered.

To isolate the failure between mechanical or electrical problems, the air hoses should be disconnected from the IF module (**IM**) and repeat steps 1-3 on the previous page.

If the condition persists, then the failure is electrical and the **IM** should be returned for an authorized repair.

If the setting is successful, the failure is mechanical, such as a blockage in the air hoses or AOA probe, etc. Identify the blockage and, once fixed, repeat steps 1-3.

**ATTENTION:** *Again, the ground calibration set-point can be reset at any time after the initial calibration. However, ALL in-flight set-points will reset and must be re-entered.*

## 1.10 In-Flight Calibration Overview:

The calibration flight(s) may be conducted under §91.407 by at least a private pilot that is rated to fly the aircraft. The adjustment and tightening of the AOA probe may be accomplished by a mechanic, a person that holds a repairman's certificate for that specific aircraft or the aircraft owner if he/she holds at least a private pilot certificate under part §43.3(g) and Appendix "A" to Part §43 item (c)(26).

This procedure may be done as a single pilot operation; however, it does require your attention to be diverted away from flying the airplane. ***In the interest of safety, we strongly recommend that you solicit the aid of someone that can perform the calibration procedure while you fly the airplane or vice versa.*** Use the following outline as a guide to complete the in-flight calibration:

- Review the aircraft records; ensure that the return to service entry has been made.
- Plan a flight to an area where slow flight can be performed without any undue hazards (reference § 91.303 & § 91.305).
- Review the stall recovery and minimum controllable flight procedures for your aircraft. If an inadvertent stall occurs, immediately recover from the stall per your training and the aircraft manufacturers instructions.
- Acquaint yourself with the Alpha Systems AOA Eagle display and its operation prior to attempting actual in-flight calibration maneuvers.

**Note:** *The OAA set-point calibration can be practiced on the ground.*

While the in-flight calibration can be accomplished by a solo pilot, it is advisable that the pilot flying focuses on safely and correctly achieving the calibration set points while a second person assists in performing the indicator calibration.

- Preflight and operate the aircraft as you would normally.
- When in an area where slow flight can be performed, perform clearing turns to ensure the area is clear.
- Make sure the winds are calm with little or no turbulence to allow an accurate calibration.
- Follow the aircraft flight procedures and slow the aircraft. Maintain coordination in the clean configuration, with aircraft engine set to lower **RPM (Pattern RPM) or Manifold Pressure**.
- Maintain altitude with the pitch (use pitch trim to relieve back pressure).
- Use power as needed to maintain safe, straight, level and slow flight.
- Perform in-flight Optimum Alpha Angle (**OAA**) calibration, fly at true **1.3Vs** (ZERO VERTICAL SPEED).
- **Once an OAA value is accepted and entered**, perform in-flight **Cruise** set-point calibration and fly at weight corrected **V<sub>a</sub>** (maneuvering speed) use that value for the AOA Cruise set-point (WHILE HOLDING ALTITUDE).
- **Once a Cruise value is accepted and entered**, perform the exit procedure (Rotary Switch position 0), save and exit from the calibration mode.
- Return to the airport and shut down the aircraft.

- If everything was set properly when the unit is turned ON, the unit will run its start-up LED segment illumination cycle and announce, “**Alpha Systems AOA Test Complete.**”

**Note:** If the AOA system indicates a bad set-point, note the display indications at the time of the CAL button push and return to the airport. Make the necessary angle adjustments to the AOA probe. When the AOA probe angle adjustments have been made, perform the entire in-flight calibration procedure, **OAA & Cruise**, as outlined in this section until you are successful.

### 1.11 In-Flight Calibration of Optimum Alpha Angle (OAA) Overview:

**CAUTION:** Always maintain complete control of your aircraft!

The Alpha Systems AOA requires calibration to each aircraft at the Optimum Alpha Angle (**OAA**) in-flight. This angle of attack is **flown** to identify the angle of attack that represents **the weight corrected, 1.3Vs** or 30% above a stall, corresponding to **OAA**.

**To accurately identify 1.3Vs:**

Calculate the true stall speed for the conditions of the current aircraft's gross weight, passengers, baggage, CG, and density altitude (**gross weight adjusted Vs**). Take the calculated number for that condition of Stall speed and multiply the calculated Stall speed by 1.3Vs (add 30%). Fly the aircraft at a safe altitude for slow flight maneuvers. Reduce to slow flight power setting such as a downwind airport power setting. Use pitch and trim flying at **Calculated 1.3Vs (OAA)** on a calm, non-turbulent day and in a **CLEAN** configuration. Stabilize aircraft's airspeed and fly straight and level (**ZERO VERTICAL SPEED**). Quickly push and release the **CAL** button, follow the OAA set-point calibration procedures.

## 1.12 (Set-Point 2) Calibrating the Optimum Alpha Angle (OAA):

Follow these steps to enter OAA calibration mode:

- 1.) Turn the power ON.
  - a. The display should flash the blue and green segments indicating Ground Calibration has been completed but the in-flight calibration must be done.
- 2.) Turn the Rotary Switch to position 2. (The wide slot identifies the selection)
- 3.) Press the SEL button.
  - a. The blue doughnut on the display will flash three times and the unit will announce “Set-point Calibration ON” followed by “Set OAA Set-point.”
- 4.) Fly the OAA Value and when ready to enter a set-point, press the CAL button.

The unit will do one of the following:

- The AOA system accepts the OAA value, illuminates the blue doughnut and the display will become semi-operational and announce “OAA Set-point Complete.”
- The AOA display will flash the red chevrons and the blue doughnut on the display three times and announce “Invalid OAA Set-point.” The set-point is too low; tip the AOA Probe 5° away from the wing (proceed to INVALID SET POINT TOO LOW in the troubleshooting section 5.9).
- The AOA display will flash the blue doughnut and the yellow chevrons on the display three times and announce “Invalid OAA Set-point.” The set-point is too high; tip the AOA Probe 5° towards the wing (proceed to INVALID SET POINT TOO HIGH in the troubleshooting section 5.9).



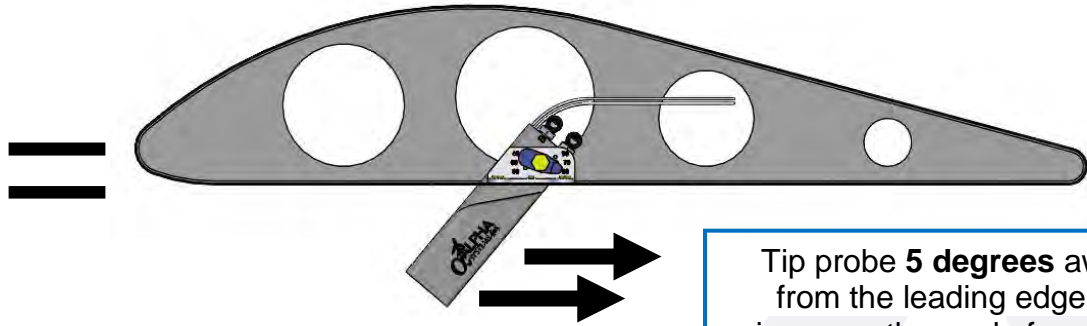
**Note:** If the AOA system indicates a bad set-point, note the display indications at the time of the button push and return to the airport. Make the necessary angle adjustments, relative to the direction of the error code, to the AOA probe. Adjust the probe in 5 degree increments. When the AOA probe angle adjustments have been made, perform the entire in-flight calibration procedure outlined in this section until you are successful

## 1.13 Invalid OAA Set Points:

### Invalid Set-Point - Too Low



If the pilot could not get a valid **OAA** value entered during the button push and the display flashed **BLUE and RED segments**, the aircraft must be landed, and the AOA probe angle must be unpinned, rotated **away from the leading edge of the wing 5 degrees** and re-pinned, allowing the new angle to be secured and tightened. The in-flight **OAA** calibration procedure must be repeated.

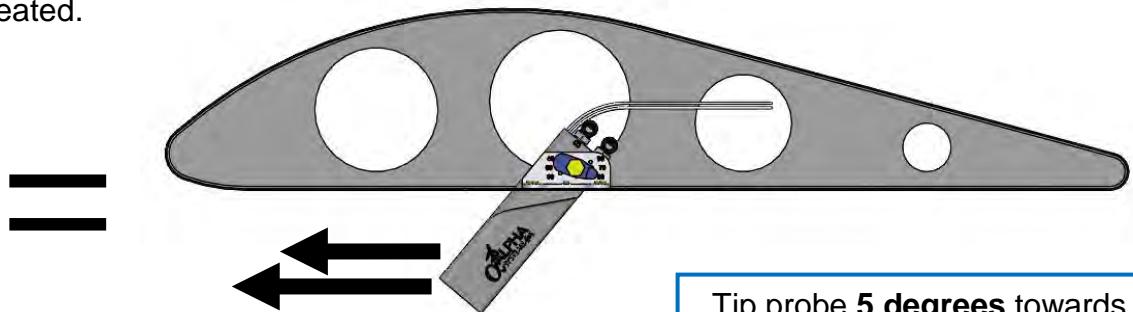


Tip probe **5 degrees** away from the leading edge or increase the angle from the front side of the probe to the mounting plate

### Invalid Set-Point - Too High



If the pilot could not get a valid **OAA** value entered during the button push and the display flashed a **BLUE and YELLOW segments**, the aircraft must be landed, and the AOA probe angle must be unpinned, rotated **toward the leading edge of the wing 5 degrees**, re-pinned and tightened. The **OAA** in-flight calibration procedure must be repeated.



Tip probe **5 degrees** towards the leading edge or decrease the angle from the front side of the probe to the mounting plate

**Note:** The **CAL** Button can be pushed as many times as desired to continuously attempt a new Optimum Alpha Angle (**OAA**) set-point. If the set-point is valid the display will be functional using the new **OAA** value. If the set-point is invalid, the display will no longer be operational and continue to flash the error colored backgrounds. As long as the unit is in the **OAA CAL** routine, it will flash the **blue segment** twice, every five to six seconds until you enter **Cruise** Calibration.

**Note:** If power is removed, the unit will become non-functional and the in-flight procedure must be started over; **unless** the calibration routine was entered after the display was already calibrated.

By turning the Rotary Switch to position 2 and pressing the SEL button AFTER the initial calibration, you can re-enter calibration mode to assign new set-points. If no new set-points are entered, the system will retain its previous settings.

### 1.14 (Set-Point 3) Calibrating the Cruise Set-Point:

**Attention:** *The unit must have a valid OAA value before it allows the Cruise set-point to be entered.*



Follow these steps to set the Cruise set-point:

- 1.) To set the Cruise set-point, **with the rotary switch still in position 2**, press the **SEL** button.
  - a. The display will flash the **green** segment three times and will announce “**Set Cruise Set-Point**”. **Cruise set-point will be indicated by the green segment**. The set-point for the lowest angle of attack calibrated and displayed, bottom of the scale, must be entered. After the **OAA** set-point is flown, identified and stored in the system, the in-flight **Cruise** set point must be entered. This set-point is identified first from the POH of the aircraft and will be **V<sub>a</sub>** (maneuvering speed), gross weight adjusted and corrected for that flight.
- 2.) Fly the aircraft at the **Cruise AOA (weight corrected, V<sub>a</sub> speed)** for that flight. Trim for straight and level flight.
- 3.) When ready, press the **CAL** button.

The unit will do one of the following:

- The **green segment** will illuminate and the unit will announce, “**Cruise Set-Point Complete.**”
- Flash the **green segment** three times on the display and announce “**Invalid Cruise Set-Point,**” if out of range.



**Note:** The **CAL** button can be pushed as many times as desired, to continuously attempt entering a new **Cruise** set-point. The pilot may have to try different speeds in order to find an acceptable set-point, or the sensor probe may need to be adjusted on the ground. The display will remain operational for both invalid and valid set-points at this point.

**Note:** As long as the unit is in the **Cruise** calibration routine, it will flash the **green segment** twice, every six seconds as a reminder that the unit is still in the **Cruise** calibration routine.

**Attention:** **The values must be saved or all values will be lost!!**

**SEE NEXT  
PAGE OR  
VALUES WILL  
BE LOST**

If the calibration values were not saved after calibrating the Cruise set-point and power is removed, you must enter both OAA and Cruise set-points again. You will see the blue and green led segments flash five times when OAA and Cruise need to be entered.

Indicates both OAA and Cruise set-points must be set.



If satisfied with both set-point values (OAA & Cruise) exit and **STORE** the set-points to memory:

- 1.) Turn the **Rotary Switch** to position **0**.
- 2.) Press the **SEL** button. The unit will announce “**Calibration Off**,” run its startup LED segment illumination sequence, and remain operational; or the unit will announce “**Calibration Fail**” and become inoperative if one of the set-points was invalid or the calibration procedure was not completed.

Rotary Switch at position 0



SEL Button

### 1.15 Calibration Set-Point Verification:

All of the required set points are entered and stored. Verify performance and valid set-points by repeating the identification of both **OAA** and **Cruise**. The display must transition smoothly through the segments from red all the way through the green bar as the AOA decreases and you approach **Cruise** and transition back through the segments up to the red as the AOA increases to **Stall**.

## 1.16 Calibrating a Stall Set-point for the Clean Position:

Stall set-points have been added to the clean OAA and Cruise set-point calibration procedure at rotary switch position 2.

**If desired**, a clean Stall set-point can be set by pressing the **SEL** button after the Cruise set-point has been set, instead of turning the Rotary Switch to position 0.

**The system will announce “Set Stall Set-point.”**

To set the Stall set-point, press the **CAL** button when at the appropriate flight pattern. **The system will save the set-point and announce “Stall Set-point Complete.”**

When done setting the Stall set-point, turn the Rotary Switch to position 0 and press the SEL button.

**The system will announce “Calibration Off.”**

**Note:** The system has been set up so that the user can set one, two, or all three Flap OAA Set-points and one, two, or three Flap Stall Set-points. This can be done by rotating the Rotary Switch to position 0 after the Flap Set-point has been set and pressing the SEL button. **The system will announce “Calibration Off.”**

## 1.17 Gear Warning Activation:

If the gear warning is installed, with power ON, turn the rotary switch to position 3 and press the SEL button to activate the gear warning audio indications. Pressing the SEL button again at this position will deactivate the gear warning function. You can turn it on or off at any time by following this process.

When the gear warning is active, a “**Gear Gear Gear**” audio annunciation will occur at the Yellow Chevron if the audio is enabled and the gear is not in the down position.

Rotary Switch at position 3



## 1.18 Setting Calibrated Day / Night Brightness Levels:

**Note:** *There are 16 levels of brightness from a minimum level to a maximum level.*

- 1.) **With power OFF**, turn the Rotary Switch to position 3.
- 2.) Hold the **SEL** button down and power the AOA ON.

The unit will announce “**Set Brightness Levels**” and all LED segments will be illuminated.

- 3.) Cover the photocell on the AOA DISPLAY with your thumb and wait 5 seconds.

Rotary Switch at position 3



**With the photocell covered:**

- 4.) Press the brightness button repeatedly on the AOA DISPLAY until at the acceptable low ambient light brightness level.
- 5.) Wait about 5 seconds for the unit to store the calibrated setting before removing your thumb.
- 6.) Now, apply light directly to the photo diode on the AOA DISPLAY and wait 5 seconds.

**With light on the photocell:**

- 7.) Press the brightness button repeatedly on the AOA DISPLAY until it is at the acceptable high ambient light brightness level.

You'll know when you are at the maximum brightness level because the unit will announce "Maximum Brightness Reached", and going past it will cause the brightness of the LED segments to return to the minimum level.

- 8.) Wait about 5 seconds for the unit to store the calibrated setting before removing the light from the photocell.
- 9.) Power the system OFF.

**1.19 Adjusting the Audio Volume Level:**

- 1.) **With power OFF**, turn the Rotary Switch to position 4.
- 2.) Hold the **SEL** button down and power the unit on.
- 3.) Wait until the unit announces "**Set Volume.**"
- 4.) Now, press the **CAL** button repeatedly until the acceptable volume level.

Rotary Switch at position 4



**Note:** When at the maximum volume level, the unit will announce "Maximum Volume Reached." When at the minimum volume level, the unit will announce "Minimum Volume Reached."

- 5.) Power the unit OFF.

**1.20 Select Audio Type:**

- 1.) **With power OFF**, turn the Rotary Switch to position 5.
- 2.) Hold the **SEL** button down, power the unit on. The unit will announce "**Set Audio Choice.**"

Rotary Switch at position 5



**Currently there are 5 choices of audio:**

A 3 beep audio tone when the AOA increases and the yellow chevron and only the first half of the blue doughnut are illuminated (audio occurs once), or:

A 2 note, high / low audio tone when the AOA and when the yellow chevron and only the first half of the blue doughnut are illuminated (audio occurs once), or:

A 2 note, high / low audio tone when the AOA increases and when the yellow chevron and only the first half of the blue doughnut are illuminated (audio occurs once) and a feminine voice “**Too Slow**” annunciation when the red chevrons and triangle are illuminated (repeats 3 times), or:

A doorbell followed by a feminine voice “**Getting Slow**” (audio occurs once) when the yellow chevron and only the first half of the blue doughnut are illuminated and a feminine voice “**Too Slow**” annunciation when the red chevrons and triangle are illuminated (repeats 3 times), or:

A doorbell followed by a feminine voice “**Slowing**” when the yellow chevron and the first half of the blue doughnut are illuminated and a feminine voice “**Too Slow**” when the red chevrons and triangle are illuminated (repeats 3 times).

3.) Press and then release the **CAL** button.

The first audio choice will sound. If the 1<sup>st</sup> audio choice is desired, power the unit OFF and it will be stored to system memory.

4.) If you want to select the next audio choice, press the **CAL** button again.

You will hear the 2nd audio choice. If the 2<sup>nd</sup> audio choice is desired, power the unit OFF and it will be stored to system memory.

5.) To select the next audio choice, press the **CAL** button again.

You will hear the 3rd audio choice. If the 3<sup>rd</sup> audio choice is desired, power the unit OFF and it will be stored to system memory.

6.) To select the 4<sup>th</sup> audio choice, press the **CAL** button again.

You will hear the 4th audio choice. If the 4<sup>th</sup> audio choice is desired, power the unit OFF and it will be stored into system memory.

7.) To select the 5<sup>th</sup> audio choice, press the **CAL** button again.

You will hear the 5th audio choice. If the 5th audio choice is desired, power the unit OFF and it will be stored into system memory.

To hear all choices again, press and release the **CAL** button again and again. The system will start with the first audio choice and all selections can be repeated until the selected audio is determined and power is removed.

## 1.21 Flap Diagnostics (Discrete):

This function will allow you to identify each input has been properly installed.

To run the flap diagnostics test, do the following:

- With power **OFF**, go to rotary switch position 7. Press and hold the SEL button.
- While holding the SEL button, turn power ON. **You will not hear an audio response.**

*Note: This 'Flap Diagnostic' function allows you to electrically test the IO system. "Active Flap Input" identifies which flap position you activate on the aircraft. "AOA Display Reference" is a description of the display response you will see.*

- While in this mode, activate a connected flap position. You should see a display response on the AOA display you have connected.

*Note: Not all aircraft require all described flap inputs to be installed. Test the flap inputs specific to the aircraft that the AOA system is being installed in.*

- Power the system OFF.

## 1.22 Calibrating Flap Set-points (Discrete):

Once the system has been successfully calibrated in the "CLEAN" configuration of BOTH **OAA** and the **CRUISE** values, and **STORING** both values, the software will allow calibration of **up to 3** additional **OAA** flap calibrations. The system has one analog I/O input and 3 discrete inputs for flap sensing. The **flap OAA** calibration process is identical to the clean configuration, fly or identify the weight adjusted stall speed for each wing configuration, Flap1, Flap2, Flap3, multiply each times 1.3, follow the procedure below by entering; **Flap 1 OAA, Flap2 OAA, Flap3 OAA**

*Note: At any time, you may turn the Rotary Switch to position 0 and press the SEL button to exit the calibration and return to active mode. The system will save any currently calibrated set-points.*

- **With POWER ON**, rotate the Rotary Switch into position 7.
- Press the SEL button. **The system will announce "Flap Calibration On," followed by "Set Flap One."**
- If a Flap 1 OAA is to be set, press the CAL button when flying @ 1.3Vs in the first flap position. **The system will save the set-point and announce "Flap One Complete."**
- If done with setting the Flap 1 Set-point or a Flap 1 Set-point is not to be set, press the SEL button to move on to the next Flap setting. **The system will announce "Set Flap Two."**
- If a Flap 2 Set-point is to be set, press the CAL button when flying @ 1.3Vs in the first flap position. **The system will save the set-point and announce "Flap Two Complete."**  
(See next page)

- If done with setting the Flap 2 Set-point or a Flap 2 Set-point is not to be set, press the SEL button to move on to the next Flap setting. **The system will announce “Set Flap Three.”**
- If a Flap 3 Set-point is to be set, press the CAL button when flying @ 1.3Vs in the first flap position. **The system will save the set-point and announce “Flap Three Complete.”**
- If done with setting the Flap 3 Set-point or a Flap 3 Set-point is not to be set, press the SEL button to move on to the Flap Stall Set-points or turn the Rotary Switch to position 0 and press the SEL button to exit to active mode. **The system will announce “Set Flap One Stall.”**

### 1.23 Calibrating Flap Stall Set-points (Discrete):

The system will remain functional without setting the Stall flap set-points. The **flap OAA** calibration process is identical to the clean configuration OAA, fly or identify the weight adjusted stall speed for each wing configuration with Flap1, Flap2, Flap3, multiply each times 1.1, follow the procedure below by entering; **Flap 1 Stall, Flap2 Stall, Flap3 Stall.**

- If a Flap 1 Stall Set-point is to be set, press the CAL button when ready. **The system will save the set-point and announce “Flap One Stall Complete.”**
- If done with setting the Flap 1 Stall Set-point or a Flap 1 Stall Set-point is not to be set, press the SEL button to move on to the next Flap setting. **The system will announce “Set Flap Two Stall.”**
- If a Flap 2 Stall Set-point is to be set, press the CAL button when ready. **The system will save the set-point and announce “Flap Two Stall Complete.”**
- If done with setting the Flap 2 Stall Set-point or a Flap 2 Stall Set-point is not to be set, press the SEL button to move on to the next Flap setting. **The system will announce “Set Flap Three Stall.”**
- If a Flap 3 Stall Set-point is to be set, press the CAL button when ready. **The system will save the set-point and announce “Flap Three Stall Complete.”**
- If done with setting the Flap 3 Stall Set-point or a Flap 3 Stall Set-point is not to be set, turn the Rotary Switch to position 0 and press the SEL button. **The system will announce “Calibration Off.”**

**(SEE NEXT PAGE FOR ANALOG FLAP INFO)**

## 1.24 Calibrating Flap Set-points/Diagnostics (Analog):

Once the system connection has been completed, perform the following to setup the Flap Analog Input sensing.

With POWER OFF, turn the Rotary Switch on the Switch Panel to position 7.

Push and hold the **SEL** button down and apply power to the system. The system will enter the Flap Diagnostic routine.

*Note: There is no audio indication for this routine.*

To set an analog input value for the a Flap 0/UP position (typically the clean position), move the aircraft's Flap to the Flap 0 position and turn the Flap 0 Trimmer POT counterclockwise on the IO module until a green LED segment is illuminated on the AOA Display. Readjust POT until satisfied with the position detection.

To set an analog input value for the Flap 1 position (in some aircraft, this could be the Take-Off Flap position), move the aircraft's Flap to the Flap 1 position and turn the Flap 1 Trimmer POT counterclockwise on the IO module until a Yellow LED segment is illuminated on the AOA Display. Readjust POT until satisfied with the position detection. The Yellow LED segment should activate at the point **just before** the flap reaches its designated position **AND STAY ON AFTER THE FLAP STOPS MOVING**.

To set an analog input value for Flap 2 position (in some aircraft, this could be the Landing Flap position), move the aircraft's Flap to the Flap 2 position and turn the Flap 2 Trimmer POT counterclockwise on the IO module until a Red LED segment is illuminated on the AOA Display. Readjust POT until satisfied with the position detection. The Red LED segment should activate at the point **just before** the flap reaches its designated position **AND STAYS ON AFTER THE FLAP STOPS MOVING**.

If Flap positions 0, 1, or 2 are not detected, the system will default to Flap position 0 (0°).

**Attention: The analog flap input cannot be used if the discrete IO inputs Flap0 thru Flap3 inputs are being used and vice versa.**




After calibration, activate any flap position and you should see a display response based on the following chart. Use the provided space below to record the flap angle for each analog flap input.

**(SEE CHART ON NEXT PAGE)**

Analog Flap Calibration Pots





Active Flap Input	AOA Display Reference
No Active Flap Inputs	Blank (No LEDs)
Multiple Active Flaps Simultaneously	Blank (No LEDs)
Flap Position 0	 <p>The image shows four views of the AOA display: a vertical view with a green bar at the bottom, a vertical view with a green bar at the bottom, a horizontal view with a green bar on the right, and a circular gauge view with a green needle pointing to the 0 mark.</p>
Flap Position 1	 <p>The image shows four views of the AOA display: a vertical view with a yellow bar at the bottom, a vertical view with a yellow bar at the bottom, a horizontal view with a yellow bar on the right, and a circular gauge view with a yellow needle pointing to the 1 mark.</p>
Flap Position 2	 <p>The image shows four views of the AOA display: a vertical view with a red bar at the bottom, a vertical view with a red bar at the bottom, a horizontal view with a red bar on the right, and a circular gauge view with a red needle pointing to the 2 mark.</p>

Use the following table to record the flap angle for each analog flap input.

Active Flap Input	Flap Angle (in Degrees)
Flap Position 0	
Flap Position 1	
Flap Position 2	

Alpha Systems provides a sticker to cover the Analog Flap Adjustment Pots after final calibration has been completed and recorded.



Add the sticker as shown in the image.



## 2. OPERATING

### 2.1 Background information:

The Alpha Systems AOA system was primarily designed to improve operational safety of airplanes by increasing pilot awareness of available lift during operations at high angles of attack. Additional benefits include identifying aircraft performance based on a fixed angle of attack or a constant  $C_L$ , such as maximum range and best glide - Stall.

**AOA: Angle of Attack** is the difference between the airfoils chord line (a line from the leading edge to the trailing edge of the wing) and the relative wind (the inverse of the aircraft flight path).

**$C_L$ : Coefficient of Lift** is a relative measure of an airfoil's lifting capabilities.

**$C_{Lmax}$ : Coefficient of Lift Maximum** is the angle of attack which if exceeded will cause the airfoil to stall.

**$C_D$ : Coefficient of Drag** is a measure of total drag; induced and parasite drag.

**$C_L/C_D$ : Coefficient of Lift over Coefficient of Drag** is a ratio between lift and drag.

**$C_L/C_D$  Maximum:** is the maximum lift-to-drag ratio at which maximum range and maximum glide distance will be found for propeller airplanes.

### 2.2 System Description and Operation:

The Alpha Systems AOA "**Eagle,**" electronic angle of attack system measures pressure at two points on a AOA probe and conveys those pressures, via AOA sense lines, to the AOA interface module (**IM**). The AOA **IM** converts those pressures into an electrical signal that is then transmitted to the display. The display interprets the signal and illuminates colored bars to convey angle of attack information to the pilot. In addition to the visual display, the AOA interface module can connect to the aircraft's audio panel and sound an alert for an impending high angle of attack as a warning tone.

The Alpha Systems AOA system draws a minimal current of approximately  $\frac{1}{4}$  Amp (250mA) of electrical power. For the system to operate correctly, it must be supplied electrical power within a range of 12 to 28VDC, be calibrated correctly and the openings on the AOA probe must be kept clear of any obstructions - mounted securely in clean air flow.

Probe heat is an option and if installed requires approximately 8 Amps of electrical power at 12 or 28VDC to operate. To extend the life of the probe's heating element, it is recommended that the probe heat **not** be used while on the ground.

## 2.3 The Indicator:

9 segments on the display are color coded and will transition and illuminate with additional available lift from RED triangle in a sequential sequence to the GREEN bar and **once calibrated**, to the angle of attack of the specific aircraft. The entire slow flight range of no lift to Cruise will allow for a possibility of 14 combinations of colored segments in the following order.

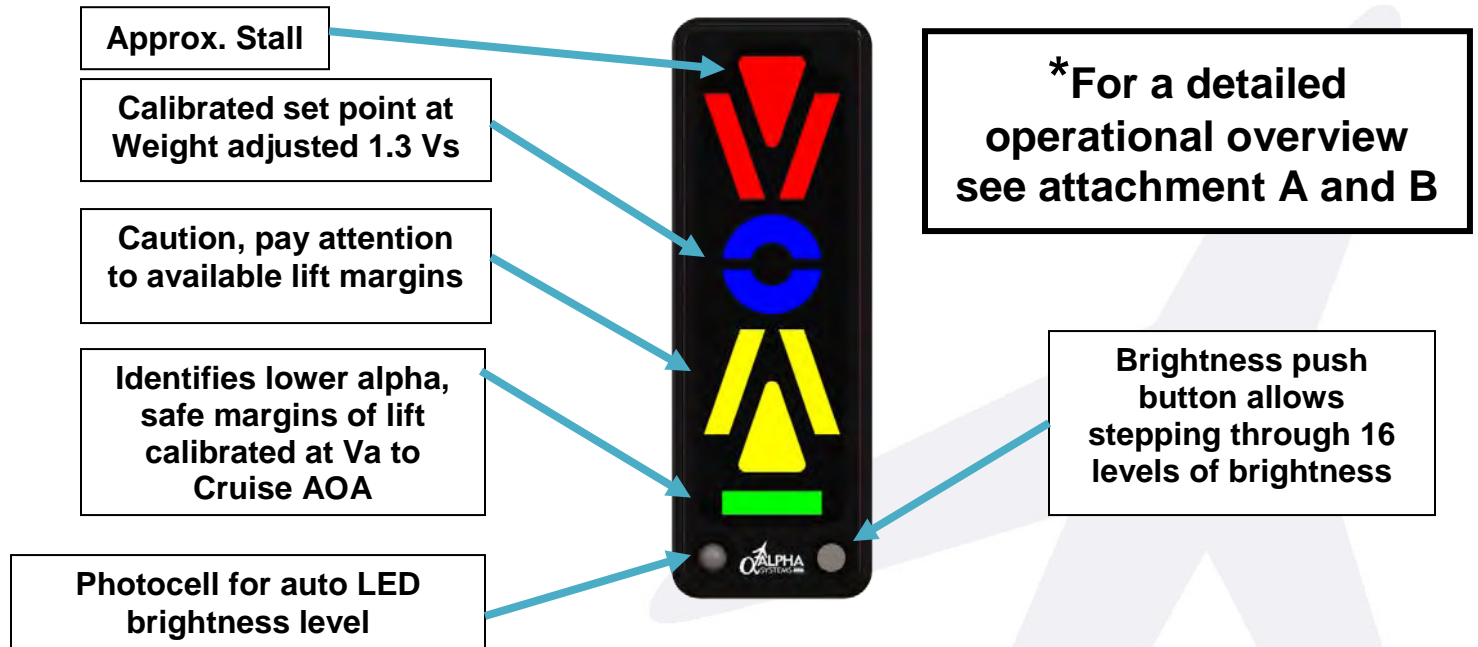
1. Green Bar (Lowest AOA)
2. Green Bar & Yellow Triangle
3. Yellow Triangle
4. Yellow Triangle & Yellow Chevrons
5. Yellow Chevrons
6. Yellow Chevrons & Blue Lower Doughnut
7. Blue Lower Doughnut
8. Complete Blue Doughnut
9. Blue Upper Doughnut
10. Blue upper Doughnut & Red Chevrons
11. Red Chevrons
12. Red Chevrons & Red Triangle
13. Red Triangle (Highest AOA)
14. No Segments Illuminated (No pressure differential)



*Note: Display shown with all segments illuminated for illustration.*

### General descriptions

- **Green Bar:** It is indicating high amounts of lift, lower angle of attack. The angle of attack is relatively low with lots of surplus lift.
- **Green Bar + Yellow Triangle:**  $V_a$  (MAA), operations allowing full deflection of flight controls.
- **Yellow Colored Segments:** It is indicating caution; the angle of attack is relatively high. If not intentional, take action to reduce the angle of attack.
- **Complete Blue Doughnut:** It is defining the segment that identifies Optimum Alpha Angle (OAA) or 1.3Vs, **30% margin away from stall (see definition)**. The system can illuminate both, just the top or just the bottom arcs to give a display just above or just below the set point.
- **Red Colored Segments** means the angle of attack is too high. Take immediate action to reduce the angle of attack such as performing a stall recovery procedure. You are in dire straits.



*Note: Display shown with all segments illuminated for illustration.*

### Optimum Alpha Angle

Optimum Alpha Angle (**OAA**) is achieved during an in-flight calibrations maneuver with the pilot taking the aircraft to altitude, then complete the following steps:

- 1.) Identify the true stall speed for that flight
- 2.) Take the true stall speed and multiply by 1.3 Vs (In the clean configuration)
- 3.) Fly the aircraft, trim for straight and level (ZERO VERTICAL SPEED).
- 4.) The pilot is to then fly the aircraft at **OAA**. Calibrate the AOA at a weight adjusted true stall speed plus 30% or 1.3 Vs airspeed at ZERO VERTICAL SPEED. The whole **blue doughnut** will illuminate when the computer accepts the value for **OAA**.

### Cruise Indication

The **Cruise** set-point is identified when the last green segment is illuminated - when the aircraft is in **Cruise** (angle of attack). The **Cruise** set-point is calibrated when the aircraft is flying at a weight adjusted **Va** (maneuvering speed).

### Max Climb Angle

Identified after the calibration procedure is complete and is when just the lower blue doughnut is illuminated. This is the indication of the aircrafts maximum angle of attack that allows a continued climb.

## Stall Indication

After the calibration is complete, the pilot will identify at what point through the transitions into the red chevron or triangle that identifies the Stall angle of attack for his or her aircraft. The relationship of the corresponding segments to the Stall is dependent on the coefficient of lift and the angle of attack for each airplane. Once identified, that illumination of red segment will always indicate the aircraft's stall.

## Other Flight Reference Values

Other flight values such as **Stall,  $V_x$  and  $V_y$**  can be identified after the AOA system has completed the calibration procedures. The pilot then flies the aircraft at the exact weight adjusted airspeed value from the pilot operating handbook that references  **$V_x$** , for example. The corresponding number of segments illuminated will always equal the associated angle of attack ( **$V_x$** ) from that day on; regardless of gross weight changes, density altitude, bank angle or CG. Simply put, once calibrated, the illuminated segments will allow the pilot to identify the margins of lift from Cruise up to Stall and instantly identify the appropriate AOA for any flight maneuver.

## Display Controls

**Brightness Button:** This button is at the bottom right of the Eagle display and when depressed and released repeatedly, will step through 16 levels of brightness. When the maximum brightness level is reached, the brightness returns to the minimum and steps up each time the button is depressed.

**Auto Brightness Photo Cell:** The photo cell is at the lower left of the AOA display automatically detects the ambient light and will switch from "day time" brightness preset to "night time" brightness presets automatically. The Brightness push button can override either preset at any time.

## Controls on the Switch Panel



**Calibration Mode Rotary Switch:** Is an 8 position rotary switch that uses the **WIDE PART OF THE SLOT** to indicate the switch position, **NOT THE ARROW**. There are markings on the case at **0,2,4,6** but can be positioned in-between to gain access to the **ODD** numbered mode procedures when directed in the calibration sequences

**CAL Button:** This button is the recessed blue button and is marked "**CAL**". This button is used to enter various calibration values (**OAA & Cruise**) during the calibration procedures.

**SEL Button:** This button is used to enter the calibration modes when the rotary switch is in the corresponding mode set position.

**Audio Mute Switch:** This switch mutes the audio warning when in the UP position.

**Audio Mute LED:** This amber led illuminates when the audio alarm has been deactivated by the audio mute switch.

## 2.4 Demonstration of Optimum Alpha Angle (OAA), Clean and Dirty:

As noted earlier, this AOA system was primarily designed to improve operational safety of airplanes by increasing pilot awareness during operations at high angles of attack. The system is calibrated with the aircraft in the **clean configuration** which means that, when the flaps are lowered, the display will indicate a higher angle of attack (**deeper into the red**) before stalling. It is our contention that **any operation in the red at low altitude is unsafe and, if encountered, immediate corrective actions should be taken to reduce the angle of attack regardless of the aircraft configuration.**

To familiarize you with the AOA indications during stalls use the following outline as a guide.

- Plan a flight to an area where stalls can be performed without any undue hazards (reference § 91.303 & § 91.305).
- Review the stall recovery procedures for your aircraft.
- Acquaint yourself with the AOA indicator and controls.
- Preflight and operate the aircraft as you would normally.
- When in an area where stalls can be performed and the air is smooth, perform clearing turns to ensure the area is clear.
- Follow the aircraft procedures and slow the aircraft, in the clean configuration (no flaps):
  - Maintain coordination.
  - Maintain altitude.
  - Monitor the AOA indicator.
  - Slow to a stall.
  - Perform the stall recovery procedure for your aircraft.

### OBSERVED INDICATIONS:

**As the aircraft slows and the angle of attack increases, note the following:**

- The LED segments on the AOA indicator will transition, starting with the green bar, through the yellow, to the blue doughnut, to the red triangle, then finally, no segments illuminated.
- The high angle of attack audio warning will sound anytime the angle of attack is increased beyond the yellow chevron bars and just the bottom of the blue doughnut is illuminated.
- The aircraft's stall warning should activate prior to the red triangle being on.
- When the airfoil stalls, the indication on the display will be in the red - typically with the red triangle shown.

**As the Recovery Progresses:**

- The AOA indicator will illuminate and transition back towards the blue then through the yellow and then finally the green.
- The aircraft's stall warning will silence.
- Basically, red is bad, green is good. Red is high angle of attack, and green is low angle of attack.



Follow the outline above again but perform the stall and recovery in the landing configuration (dirty) and observe the following:

- The LED segments on the AOA indicator will transition starting with the green bar through the displays scale to the last red segment.
- The High Angle of Attack Audio Warning will sound anytime the angle of attack is increased where the yellow chevron and the first half of the blue doughnut is on.
- The aircrafts stall warning will activate when the red triangle and chevrons are on.
- When the airfoil stalls, identify the offset of the AOA indication that's shown in the landing (dirty) configuration. For most aircraft, the AOA indication is the same; some may show that the Stall occurred deeper in the red. Identify the difference between clean and dirty.

#### As the Recovery Progresses:

- The AOA indicator will again start to transition from the red then blue, yellow followed by the green bar in Cruise.
- The aircrafts stall warning will silence.

Practice these two stalls until you become familiar with the indications on the AOA and your airspeed indicator. Since the airfoil on your aircraft will stall at the same angle of attack every time, (**regardless of weight**) the AOA indications should be the same every time. To prove this, try an accelerated stall in the clean configuration using the same outline as above. Notice that as the wing loading is increased in turn, the aircraft stalls at a **higher indicated airspeed** but **at the same angle of attack**.

Do you remember, ever since you were a student pilot you heard that an aircraft can stall at any airspeed, attitude or power setting? Now you have an instrument that will indicate the angle of attack and an impending stall **every time, regardless of airspeed, attitude or gross weight**.

## 2.5 Demonstration of Takeoff and Climb Using AOA:

The use of AOA for takeoff and climb performance will greatly increase the pilot's awareness while operating at high angles of attack and yield safe and consistent results.

For example, if you intend to perform a short field takeoff over an obstacle there are a number of factors you must consider arriving at the proper indicated airspeed for the climb. Changing gross weight, pressure altitude and temperature will all have an effect on the indicated climb speed. On the other hand, once you establish the correct angle of attack for the climb, it will be the same regardless of the factors previously mentioned.

To determine the correct AOA for a climb, we need a base line to start from. For this example, we will figure it out for  $V_x$  (best angle of climb). Some aircraft may use two different speeds based on the aircraft configuration. Let's use the one for clearing an obstacle on takeoff. Refer to the aircraft manual to determine the configuration and airspeed for  $V_x$  considering the following factors:

- Identify actual gross weight.
- Pressure altitude, at the demonstration altitude.
- Temperature, at the demonstration altitude.
- Correct CAS for installation errors to arrive at IAS.

As before, to familiarize you with the AOA indications for  $V_x$ , use the following outline as a guide:

- Plan a flight to an area where the desired maneuvers may be performed without any undue hazards (reference § 91.303 & § 91.305).
- Acquaint yourself with the AOA indicator.
- Preflight and operate the aircraft as you would normally. (Continued on next page)
- When in the area, perform clearing turns to ensure the area is clear.
- Maintain coordination.
- Maintain altitude.
- Use power to slow and configure for  $V_x$ .
- Maintain the indicated airspeed for  $V_x$ .
- Observe the AOA indication and make a mental note.
- Return to normal flight.
- Write down the last LED illuminated.

This AOA indication will be accurate for future use at any gross weight or altitude, **every time**. Also, this same method may be used to determine the AOA for any climb. Now try it for  $V_y$  (best rate of climb) using the procedure described above.

Document the angles of attack by the segment illuminated in a permanent record for future use (for example:  $V_x$  = Yellow Chevron).

Now practice the use of the AOA for takeoff at airports that give you a comfortable margin. Then when you perfect the technique you can perform short field over an obstacle takeoffs safely.

Use the following outline as a guide:

- Review your aircraft procedures for short field over an obstacle takeoff.
- Plan for a flight at an airport where normal takeoffs and landing may be performed.
- Preflight and operate the aircraft as you would normally.
- Perform the takeoff run as specified in the aircraft manual.
- At the specified takeoff speed rotate smoothly to the AOA for  $V_x$ .

**WARNING: Do not over-rotate or rotate too rapidly as either will cause catastrophic results.**

- When well above the obstacle, decrease the AOA and clean up on schedule.
- Adjust the pitch to achieve the AOA for  $V_y$  and continue the climb.

### Takeoffs

As the aircraft accelerates down the runway, the AOA indicator will start to transition to the segment that represents  $V_x$  until rotation. When the pitch is rotated up, the AOA indication will move towards  $V_x$ . Adjust the pitch to maintain the  $V_x$  angle. To accelerate and clean up, the pitch is lowered, thus lowering the AOA and decreasing induced drag. This will allow the aircraft to accelerate so the flaps can be retracted. The changes in angle of attack can be observed.

## 2.6 Demonstration of Performance Based on a Constant AOA or $C_L$ :

As mentioned earlier, the AOA may be used for identifying aircraft performance based on a fixed angle of attack or a constant  $C_L$ . For this discussion,  $C_L/C_D$  maximum indication will be identified. This is the maximum lift-to-drag ratio at which maximum range and maximum glide distance will be found for propeller airplanes.

For those of you that really get into researching, find the data on the airfoil that is installed on your aircraft. Compare the  $C_L$  at various angles of attack to  $C_D$  for your aircraft at respective angles of attack. The angle of attack that provides the maximum ratio between  $C_L$  and  $C_D$  is considered  $C_L/C_D$  Maximum.

OR

For the rest of us, the aircraft manufacturer has already figured this out. They show it as a calibrated airspeed that will result in an angle of attack that is  $C_L/C_D$  Maximum. They had to present the information in this fashion because they did not install an angle of attack indicator on the aircraft. To find the angle of attack for best glide, calculate an indicated airspeed considering:

- Actual gross weight.
- Pressure altitude at the demonstration altitude.
- Temperature at the demonstration altitude.
- Correct CAS for installation errors to arrive at IAS.

As before, to familiarize you with the AOA indications for  $C_L/C_D$  maximum, use the following outline as a guide:

- Plan a flight to an area where the desired maneuvers may be performed without any undue hazards (reference § 91.303 & § 91.305).
- Acquaint yourself with the AOA indicator.
- Preflight and operate the aircraft as you would normally.
- When in the area perform clearing turns to ensure the area is clear.
- Maintain coordination.
- Maintain altitude.
- Use power to slow and maintain best glide speed.
- Observe the AOA indication; this is  $C_L/C_D$  maximum.

This AOA indication will be correct for future use at any gross weight or altitude, **every time**.

Document the angles of attack by the LED segments that are illuminated. For example: best glide equals both blue and yellow LED segments illuminated.

The methods used to arrive at this AOA indication will be the same for all constant angle of attack or  $C_L$  maneuvers.

## 2.7 Demonstration of Approaches Using AOA:

A long standing rule of thumb is to use an approach speed of 1.3 times the power off stall speed in the landing configuration. Another rule of thumb is in gusty winds add 5kts. for mom and if it's really gusty add 10kts. for mom and the kids. While flying the approach at higher speeds seems to be safer, having additional speed and kinetic energy on a short runway may not be in the best interest of mom and the kids. With the means to accurately know and control the angle of attack, you can fly a more stable approach and land with less kinetic energy for any given situation than flying arbitrary approach speeds. Flying an approach and landing using an AOA indicator may be a safer procedure.

The AOA has been calibrated for an angle of attack just slightly less than  $C_{LMAX}$ . However, an acceptable margin above that angle to fly approach and landings has not been determined. As a starting point use the aircraft manual to determine the stall speed of the aircraft at the **actual gross weight** in the landing configuration. Take that calibrated airspeed and multiply it by 1.3, 1.2 and 1.1. Then refer to the airspeed correction chart to determine the correction, if any, to convert from calibrated airspeed to indicated airspeed for the three speeds. For example:

Calibrated Stall Speed X 1.3 = App. CAS ± the correction = App. IAS  
 58Kts. CAS X 1.3 = 75.4kts. CAS + 2 kt correction = 77kts. IAS  
 58Kts. CAS X 1.2 = 69.6kts. CAS + 3 kt correction = 73kts. IAS  
 58Kts. CAS X 1.1 = 63.8kts. CAS + 4 kt correction = 68kts. IAS

For ease of discussion, let's call these speeds and the resulting AOA indication as 3, 2 and, 1 respectively. Once the AOA angles have been identified, they will be **accurate at any gross weight, every time.**

To establish angles of attack for approach using AOA indications use the following outline as a guide.

- Plan a flight to an area where stalls and slow flight can be performed without any undue hazards (reference § 91.303 & § 91.305).
- Review the stall recovery procedures for your aircraft.
- Acquaint yourself with the AOA indicator.
- Preflight and operate the aircraft as you would normally.
- When in an area where stalls and slow flight can be performed and the air is smooth, perform clearing turns to ensure the area is clear.

**CAUTION: IF THE AIRCRAFT IS INADVERTENTLY STALLED, PERFORM THE STALL RECOVERY PROCEDURE FOR YOUR AIRCRAFT.**

- Follow the aircraft procedures, slow and configure to the landing configuration:
  - Maintain coordination.
  - Maintain altitude with the pitch (use pitch trim to relieve back pressure).
  - Use power as needed to maintain flight at the first of the calculated approach speeds, 3.
  - Write down the correlated LED segment.
  - Use power as needed to slow to and maintain flight at the second of the calculated approach speeds, 2.
  - Write the correlated LED segment.
  - Use power as needed to slow to and maintain flight at the third of the calculated approach speeds, 1.
  - Write down the correlated LED segment.
  - Return to normal flight.

Document the angles of attack by the number of the last correlated LED segment in a permanent record for future use. For example: 3 = 1.3 approach is equal to the blue doughnut being illuminated.

To familiarize you with the aircraft while flying practice approaches using the AOA indicator as a guide, please use the following outline:

- Plan a flight to an area where stalls and slow flight can be performed without any undue hazards (reference § 91.303 & § 91.305).
- Review the stall recovery procedures for your aircraft.
- Acquaint yourself with the AOA indicator.
- Preflight and operate the aircraft as you would normally.
- When in an area where stalls and slow flight can be performed and the air is smooth, perform clearing turns to ensure the area is clear.
- Follow the aircraft procedures, slow and configure to the landing configuration:
  - Maintain coordination.
  - Set the power as you would to fly a normal approach.
  - Maintain altitude with the pitch until the AOA approaches the 3 indication. Lower and use pitch to maintain that AOA (use pitch trim to relieve back pressure).
  - Fly the aircraft in the descent (straight & turning). Pay attention to the flight control effectiveness.
  - While the aircraft is still at a safe altitude, simulate a landing flare by reducing the power to idle and increasing the angle of attack to maintain altitude until the stall (note the relative time in seconds from the start of the simulated landing to the stall).
  - Perform a stall recovery.
  - Climb back to the initial altitude.

**Note:** Repeat the steps above using AOA indications 2 and 1. Gain experience by practicing these simulated approaches and landings using the AOA indicator.

Some noticed observations:

- The control effectiveness decreased with higher angle of attack.
- The higher the angle of attack, the more attention has to be given to rudder inputs to compensate for adverse yaw.
- Approaches at the higher angles of attack left little time between starting the flare and stall.

Some techniques and things to consider when using an AOA to fly the approach:

- Coordinate the use of pitch and power to fly the approach and landing.
  - **Use PITCH primarily to control the AOA**
  - **Use POWER primarily to control the descent rate.** (Keep in mind how much power it took to maintain altitude)
- A stable approach all the way to the runway is much safer than making radical changes to the AOA or descent rate once an obstacle is cleared.
- **Set a safe standard for yourself using all your experience to set a maximum AOA for any approach and do not let pressures cause you to fly an approach at too high of AOA.**
- When flying in gusty conditions, fly a lower AOA so that when a wind gust changes your angle of attack it does not exceed **your maximum AOA.**
- Having a great new system to indicate angle of attack does not change the laws of physics. Use it as a new tool to fly safe.
- If you are planning to use the AOA to land on a postage stamp, use your excellent judgment skills so you don't have to use your exceptional pilot skills just to survive.

## 2.8 Post Calibration Testing:

A correctly calibrated Alpha Systems AOA will provide a linear increase in AOA indication as the aircraft slows. The Alpha Systems AOA is not a certified stall warning system. If the aircraft is equipped with a certified stall warning system, the following test must be performed upon completion of the system calibration. This test is to ensure that the final alert is active prior to the stall warning from the certified stall warning system in order to ensure no conflicting information is provided. Ensure during post-calibration testing that the final Alpha Systems AOA alert state is displayed prior to any stall indications.

- Plan a flight to an area where high AOA flight can be performed without any undue hazards (reference § 91.303 & § 91.305).
- Review the stall recovery procedures for your aircraft. If an inadvertent stall occurs, immediately recover from the stall per your training and the aircraft manufacturer's instructions. At no time is a stall required to correctly calibrate or operate the AOA system.
- Acquaint yourself with the Alpha Systems AOA indicator and its functions.
- Preflight and operate the aircraft as you would normally.
- When in an area and at a safe altitude that safe operation at slow flight can be performed and the air is smooth, perform clearing turns to ensure the area is clear.
- Follow the aircraft procedures and slow the aircraft, in the clean configuration (No Flaps).
- Maintain coordination.
- Maintain altitude.
- Monitor the Alpha Systems AOA indicator.
- Slow to just above the stall and ensure that the final Alpha Systems AOA alert state is displayed prior to any stall indications. If any stall warning device activates or an impending aerodynamic stall is imminent, recover immediately using the appropriate procedure for your aircraft.
- Return to normal flight.
- If the aircraft stall warning device activated prior to the final "Too slow Too slow" alert with flashing red arrow repeat the calibration procedure as described in section 4 of this Installation Manual.

**We just barely scratched the surface of aerodynamics. If you are interested in learning more, may we suggest obtaining a copy of "The Advanced Pilot's Flight Manual" by William K. Kershner published by Aviation Supplies & Academics, Inc. (ASA).**

**There is a wealth of knowledge to be found by visiting the FAA's website about flight training information such as what can be found in the Pilot's Handbook of Aeronautical Knowledge. Please visit [www.FAA.gov](http://www.FAA.gov) to learn more.**

**FLY SAFE!**

### 3. CONTINUED MAINTENANCE

Maintenance and upkeep of the Alpha Systems AOA Eagle unit is very simple. All of the aluminum parts have been anodized for maximum protection. There are NO overhaul time requirements.

#### 3.1 Probe Maintenance:

During calibration, the probe angle was locked with the **BLUE** safety pin plate and secured with the probe mounting bolt. Confirm that the probe is tight; mounted securely and there are no visible cracks in the mounting plate or probe. The inspection plate screws must be secure and the mounting plate shows no sign of wear or cracking around the screw heads. If the probe plate is to be removed, assure hoses and fittings are tight and hoses are inserted completely into connectors and are not kinked. After re-installation assure probe angle is as originally mounted and re-check in-flight calibration set points and other in-flight dynamic values are at the same calibrated colored segment illumination reference points.

#### 3.2 Display Maintenance:

The Alpha Systems AOA display should be inspected to ensure that it is securely mounted to the instrument panel or glare shield. It should not be loose and all mounting screws should be tight. Each time the AOA is turned on, the unit illuminates each individual colored segment until all segments are ON, and then turns each segment OFF. Verify each segment turns ON and OFF independently. Verify set-points and the other aerodynamic values are still identical to the calibrated illuminated color segments that had been previously set.

#### 3.3 AOA Interface Module (IM) Maintenance:

Verify all electrical connectors are completely inserted and all connections are tight. Electrical wires and connections are secure and no cuts or wear is visible on the wire. The AOA Interface Module mounting screws are tight and no cracks or loose brackets are present. Hoses are inserted completely – no kinks, wear, or depressions.

Basically, if you believe that the lines may be blocked, cut or kinked, remove the lines from the AOA IM and blow air from the cockpit **out** towards the probe. This will remove the obstruction and test the lines integrity from the inside of the cockpit out to the AOA probe mount. Verify hoses are intact with no leaks and are not restricted or kinked in any way. If there is any doubt, **DO NOT** rely on the instrument and have a mechanic check on the installation or call the Alpha Systems Company.

**Note:** *Verify correlation of the illuminated colored segments to aircrafts AOA. Recalibrate when ANY AOA probe angle changes or adjustments are identified or completed.*

**CAUTION: DO NOT BLOW INTO THE PROBE.**

If the calibration is in question, **recalibrate as per manual.**

The Eagle AOA display will illuminate varied colored segments with repeated responses to the same aircraft AOA after calibration. Verify as to the calibration procedures contained herein this manual. If the responses are different or don't respond in a smooth transition from the **Cruise** setpoint to **OAA**, and from **OAA** to **Stall**, or from no colored segments on the ground, a linear transition through all of the segments illuminating one by one until the **Cruise** set point is reached, (green bar) **recalibrate.**

If the recalibrations are unsuccessful, have the mechanic inspect ALL installation mounts, tubes, fittings, verify AOA probe holes are clear and hoses are not cut.

**If reattempts at calibrations are unsuccessful,  
call Alpha Systems AOA/DepotStar, Inc. for customer service.  
763-506-9990**

**We appreciate the opportunity to provide an instrument that will aid every pilot with additional information, increasing pilot awareness of lift when in flight. Alpha Systems is committed to support the GA community with innovative solutions and improvements to all of our Angle of Attack Systems.**

**Please tell all your friends and fellow pilots about  
Alpha Systems AOA!**

**“OUR MISSION IS FLYING SAFER”**