Alpha 180 and 210

Owner / Service Manual

June 2015

Alpha 180 and 210

June 2015 - First Edition

500 West Blueridge Ave • Orange, CA • 92865 • Phone (714) 998-6359 • FAX (714) 998-0647
http://www.willswing.com • E-mail: comments@willswing.com

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Introduction

Thank you for purchasing a Wills Wing glider, and welcome to the world wide family of Wills Wing pilots. We are a company of pilots and aviation enthusiasts, and our goal is to serve your flying needs now and in the future, as we have done for pilots throughout the world since 1973.

We encourage you to read this manual thoroughly for information on the proper use and maintenance of your Wills Wing glider. If at any time you have questions about your glider, or about any aspect of hang gliding that your Wills Wing dealer cannot answer, please feel free to give us a call.

Please visit our web site at http://www.willswing.com on a regular basis. The site features extensive information about Wills Wing gliders and products, a Wills Wing Dealer directory, a comprehensive list of service and technical bulletins, current editions of owners manuals, our complete retail price list, a search engine, and more. Our web site is the means by which we will communicate with you when we have service advisories or other information related to your safety that we need to make you aware of.

We wish you a safe and enjoyable flying career, and, once again, welcome aboard!

Mike Meier, Linda Meier, and Steve Pearson

Wills Wing, Inc.

Disclaimer And Warning

Hang gliding is a form of aviation. Like any form of aviation, its safe practice demands the consistent exercise of pilot skill, knowledge of airmanship and weather, judgment and attention at a level which is appropriate to the demands of each individual situation. Pilots who do not possess or exercise the required knowledge, skills and judgment are frequently injured and killed. The statistical rate at which fatalities occur in hang gliding is approximately one per thousand participants per year.

The Federal Aviation Administration does not require a pilot's license to operate a hang glider. Hang gliders and hang gliding equipment are not designed, manufactured, tested or certified to any state or federal government airworthiness standards or requirements. Hang Gliders are not required to be registered with the Federal government. As a result, we do not have a reliable way to keep track of contact information for the owners of Wills Wing hang gliders. It is your responsibility to check with us periodically for safety and airworthiness advisories and information related to your glider. The easiest way to do this is to check our web site at http://www.willswing.com Wills Wing hang gliding products are not covered by product liability insurance. You should never attempt to fly a hang glider without having received competent instruction. We recommend that you not participate in hang gliding unless you recognize and wish to personally assume the associated risks.

Please fly safely.

Wills Wing, Inc.

Technical Information And Placarded Operating Limitations

The Alpha 180 and 210 have been tested and found to comply with the 2014 HGMA Airworthiness Standards. At the time of this writing – June 1st, 2015, no certificates of compliance have been issued for these models. Please see www.HGMA.net for updated information on the HGMA certification status of any hang glider

The HGMA Certification standards require:

1. A positive load test at root stall angle of attack at a speed equal to at least the greatest of:
    a. 141% of the placarded maximum maneuvering speed
    b. 141% of the placarded maximum rough air speed
    c. 123% of the placarded speed never to exceed

    for at least three seconds without failure.

    The required test speed for the Alpha was 54 m.p.h..
2. A negative 30 degree angle of attack load test at a speed equal to at least the greatest of:
    a. 100% of the placarded maximum maneuvering speed
    b. 100% of the placarded maximum rough air speed
    c. 87% of the placarded speed never to exceed

    for at least 3 seconds without failure.

    The required test speed for the Alpha was 38 m.p.h..
3. A negative 150 degree angle of attack load test at a speed equal to at least the greater of 26 mph or 50% of the required positive load test speed for at least 3 seconds without failure.

    The required test speed for the Alpha was 27 m.p.h..
4. For the Alpha 180 and 210, pitch tests at speeds of 20 m.p.h., 32 m.p.h. and 44 m.p.h. which show the glider to have a positive pitching moment coefficient over a range of angles of attack from trim angle to 20 degrees below zero lift angle at 20 m.p.h., and from trim angle to 10 degrees below zero lift angle at 32 m.p.h., and from 10 degrees above zero lift angle to zero lift angle at 44 m.p.h.
5. Flight maneuvers which show the glider to be adequately stable and controllable throughout the normal range of operation.

The Alpha 180 and 210 have been designed for foot launched soaring flight. They have not been designed to be motorized, tethered, or towed. They can be towed successfully using proper towing procedures. Pilots wishing to tow should be USHGA skill rated for towing, and should avail themselves of all available information on the most current proper and safe towing procedures. Suggested sources for towing information include the United States Hang Gliding Association and the manufacturer of the towing winch / or equipment being used. Wills Wing makes no warranty of the suitability of the glider for towing.

Flight operation of the Alpha should be limited to non aerobatic maneuvers; those in which the pitch angle will not exceed 30 degrees nose up or nose down from the horizon, and the bank angle will not exceed 60 degrees. The Alpha is generally resistant to spinning, but will spin from a stalled turn if the pilot applies positive pitch control in a moderate to steep bank at a high rate or in combination with roll control input so as to roll towards the high wing. Recovery from a spin requires unstalling of the wing, and it is therefore important that in the event of a spin, no application of nose up pitch control be held. The Alpha will recover from a spin once control pressures are relaxed. As the nose lowers and the angle of attack is reduced, the stall will be broken and the spin will stop. However, such recovery will consume significant altitude, and will result in the glider assuming an unpredictable heading. Recovery from a spin may therefore involve a flight trajectory which intersects the terrain at a high rate of speed. An aggravated spin could result in loss of control, in flight inversion, and structural failure. Therefore no attempt should ever be made to deliberately spin the glider. Care should be taken not to set the hang point too far aft in a manner that causes the trim speed to be too close to the stall speed, as this will increase the chance of entering a spin inadvertently. (See the sections in this manual on "Using Wing Tufts" and "Trimming The Glider In Pitch" for more information.

The maximum steady state speed for a prone pilot in the middle of the recommended weight range full forward on the control bar is approximately 34 mph for the Alpha 210 and approximately 37 mph for the Alpha 180. The placarded speed never to exceed for the Alpha is 44 mph, and the maneuvering / rough air speed is 38 mph. The Alpha can be flown in steady state high speed flight with the pilot full forward over the bar in a normal prone position without exceeding the VNE speed, however maneuvering flight may result in speeds in excess of Vne. Abrupt maneuvers should not be made at speeds above 38 mph.

The stability, controllability, and structural strength of a properly maintained Alpha have been determined to be adequate for safe operation when the glider is operated within all of the manufacturer specified limitations. No warranty of adequate stability, controllability, or structural strength is made or implied for operation outside of these limitations.

The stall speed of the Alpha at maximum recommended wing loading is 25 mph or less. The top (steady state) speed at minimum recommended wing loading for a prone pilot with a properly designed and adjusted harness is at least 32 mph.

All speeds given above are indicated airspeeds, for a properly calibrated airspeed indicator mounted in the vicinity of the pilot. Such an airspeed indicator is available through your Wills Wing dealer.

The recommended hook in pilot weight range for the Alpha is:

Apha 180: 125 – 200 lbs
Alpha 210: 150 - 280 lbs.

Be advised that pilots with hook in weights of less than 120% of the minimum hook in weight will find the Alpha somewhat more demanding of pilot skill to fly, and that pilots hooking in at more than 85% of the maximum hook in weight some relative degradation of optimum sink rate performance due to their higher wing loading. Please note that the term "recommended pilot hook in weight" refers to the weight range within which the glider meets the basic minimum performance and handling standards for which the glider was designed. When choosing among two sizes, the more appropriate information to use would be the optimum pilot hook in weight range which is 144 lbs to 175 lbs for the Alpha 180, and 176 lbs to 240 lbs for the Alpha 210.

A minimum USHGA Novice (II) level of pilot proficiency is required to fly the Alpha safely, unless under the direct supervision of a qualified instructor.

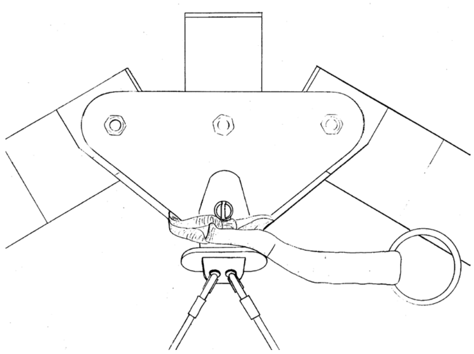
Operation of the glider by unqualified or under qualified pilots may be dangerous.

Due to the limited speed range of the Alpha and the relatively low glide ratio when flown at its maximum speed, particular care should be exercised when flying in winds of more than 10 mph.

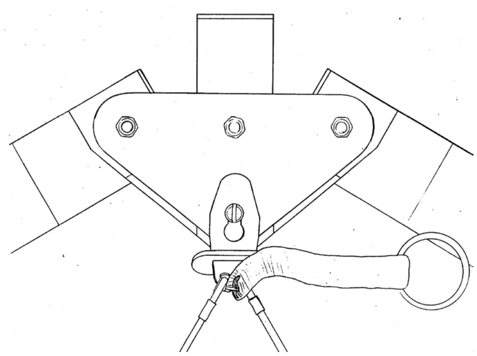
Operating the Alpha outside of the above limitations may result in injury and death. Flying the Alpha in the presence of strong or gusty winds, or turbulence may result in loss of control of the glider which may lead to injury and death. Do not fly in such conditions unless you realize and wish to personally assume the associated risks. Wills Wing is well aware that pilots have, and continue to perform maneuvers and fly in conditions which are outside the recommended operating limitations stated herein. Please be aware that the fact that some pilots have exceeded these limitations in the past without dangerous incident does not imply or insure that the limitations may be exceeded without risk. We know for a fact gliders which meet all current industry standards for airworthiness can and do suffer in flight structural failures, both as a result of turbulence, and as a result of various maneuvers outside the placarded operating limitations, including, but not necessarily limited to aerobatics. We do not know, and cannot know, the full range of maneuvers or conditions which may cause the pilot's safety to be compromised, nor can we test the glider in all possible circumstances.

A Note About Platform Towing

When platform towing, it is necessary to attach a nose line to the front of the glider, to restrain the glider at the proper pitch attitude while on the tow platform. If the noseline is installed improperly, it is possible for it to cause the bottom front wires to become detached from the nose of the glider as the glider departs the platform during launch, which will result in a complete loss of control of the glider and a very dangerous crash. Please see the diagrams below for the correct way and one incorrect way to install the nose line.



Correct Attachment



Incorrect Attachment - Unsafe!

When routed incorrectly, the nose line is simultaneously pulling down on the keel, and forward on the front wires and/or tang - which is exactly what is required to disengage the tang from the keyhole collar. In addition, because the nose line also normally pulls forward from the nose of the glider, it will normally restrain the front wires in approximately the normal position, until tension on the nose line is released upon launch from the platform. As a result, it may not be apparent that the front wires have become disconnected, or are in danger of being disconnected from the nose.

Please note that the nose line must not be routed in any way such that it can pull forward on the nose wires or the nose tang. The incorrect routing shown is one example of a way in which this could happen. It could also happen, however, if the nose line is routed outside the V of the wires, but behind the tang handle.

Please note that the button safety lock may not be effective in preventing the nose wires from being disconnected by an improperly routed nose line. Make sure that the nose cone is not installed in such a way as to depress the button lock.

All pilots planning to platform tow using a Wills Wing glider fitted with the keyhole tang nose catch must, as their last checklist item prior to "going to cruise," positively verify that the nose line is not routed in such a way that there is any possibility that it can cause the nose wires to disconnect.

A Note About High Duty Cycle Operations

Gliders which are used in a training environment, or in any situation which involves a high number of flight operations over short period of time, will require an accelerated maintenance program in order to maintain adequate airworthiness. The design and testing of these gliders does not necessarily take into account the types of wear which may result from high duty cycle operations. The operator must take responsibility to thoroughly and adequately inspect the glider to determine whether maintenance is being conducted on a schedule appropriate to maintain the airworthiness of the glider.

A Note About Parts Replacement

When ordering replacement parts, it is very important to provide the glider serial number to insure that the correct replacement parts are provided. The serial number is a five digit number, and can normally be found in three places on the glider - written inside the nose of the sail (most reliable), on an adhesive label on the bottom of the keel at the nose, and written on the operating limitations placard on the bottom of the rear of the keel.

Alpha Breakdown Procedure For Shipping And Reassembly Procedure

The Alpha 180 and 210 can be broken down to approximately 12.5 feet and 13.5 feet respectively by removal of the rear leading edges. The rear leading edge is pinned at its forward end with a clevis pin which secures it to the front leading edge spar.

To break down the leading edges follow these steps

1. Lay the glider on the ground or floor, unzip and remove the bag and remove the Velcro ties. Undo the velcros which hold the sail around the sail mount plug and pull the sail rearward at each tip to dismount the sail from the rear leading edge. You may use a large, flat bladed screw driver to pry to sail mount webbing away from the slotted endcap. Take care that the screwdriver does not have any sharp edge with might cut or damage the webbing.
2. Obtain an indelible marker. Mark the rear leading edges left and right (remember that left and right are reversed if the glider is lying "on it's back", upside down.
3. Remove the clevis pin that secures the rear leading edge and pull it straight aft to disengage it from the front. Put tape on the sharp edges of the front end of the rear leading edge tubes.

4. Lay the mylar pockets flat so as to avoid creasing the mylar when you fold over the rear portio of the sail. Replace the sail ties loosely, zip up the bag, and carefully fold the rear of the sail over against the front.

Remounting the rear leading edges

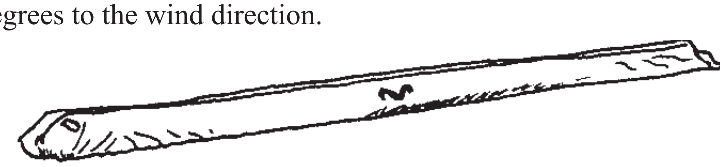
1. Set the glider on its back (upside down). Unfold the glider, open the bag and lay the sail out full length. Make sure you are mounting the correct leading edge rear into the correct front (check the "right" / "left" designation) and remember that left and right are reversed when the glider is lying upside down, on its back.
2. Wipe the forward six inches of the rear leading edge with a clean cloth to remove any dirt or grit.
3. Slide the rear leading edge tube into the sail and then into the front leading edge, as far as it will go until you encounter a hard stop. This will be the forward edge of the rear leading edge contacting the the front leading edge.
4. Rotate the rear leading edge so that the washout tube receptacle faces inwards, towards the opposite leading edge and “down” towards the ground (upwards relative to the glider) while maintaining forward pressure on the rear leading edge. Somewhere in this range of orientation, the hole through the front leading edge sleeve will line up with the corresponding hole in the rear leading edge. Install the clevis pin with the head in the forward and the safety on the back of the leading edge. Pull the sail down the leading edge.
5. Remount the sail to the rear leading edge, making sure to align the inner sail mount webbing (NOT the outer handle webbing) squarely in the slot and attach the securing velcros. Verify that the sail is oriented properly – the hole in the bottom surface for the washout tube should align with the washout receptacle.

You may find it helpful to use a large, flat bladed screw driver to pry the sail mount webbing over the end of the leading edge tube and into the slot. Take care not to damage the webbing. Alternately, first remove the sail mount screws located at the front of each leading edge to release the tension. The sail mount screws may be difficult to replace until after the glider is completely assembled. Spread the wings carefully and incrementally while pulling the sail forward at the nose during assembly to prevent damage to the sail.

Alpha Set-Up Procedure

The Alpha has not been designed to be set up while flat on the ground, or to be laid flat on the ground after set-up – the geometry of the airframe, particularly on the 210, does not allow this. Use the following procedure to set up the Alpha.

1. With the glider in the bag, lay the glider on the ground, zipper up, with the nose into the wind. If there is more than five mph of wind, or if the wind is gusty, turn the glider slightly more than 90 degrees to the wind direction.



2. Undo the zipper, remove the battens, and remove the control bar bag.

3. Separate the control bar legs.

    a. Remove the safety ring, speed nut and bolt from the corner bracket.

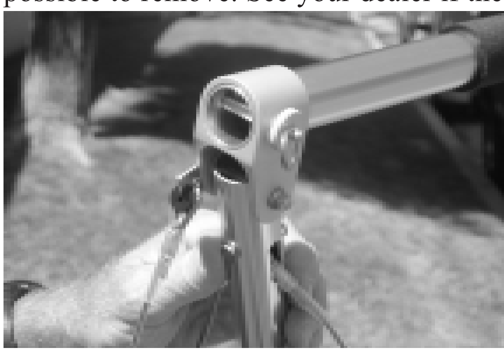
    b. Insert the basetube into the corner bracket so that the holes line up.

    c. Install the bolt, nut and safety, securing the bracket to the basetube.

Make sure that the bolt passes through both the bracket and the basetube, thus securing the basetube to the bracket.

Proper orientation of the basetube during installation will result in the "Wills Wing" sticker being on top of the basetube and right side up when viewed while hooked into the glider in the normal flying position.

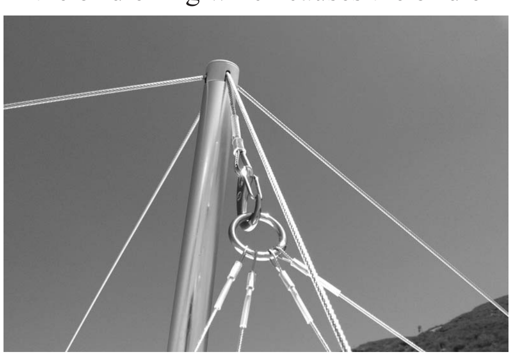
Do not insert the basetube into the fitting at an angle, and do not force the fitting onto the basetube if it does not slide on freely. Check for dirt or damage to the inside of the fitting or the outside of the basetube. If the fitting is forced onto the basetube, it may be impossible to remove. See your dealer if the fitting becomes difficult to install or remove.




4. Flip the glider upright and set it on the control bar, and remove the glider bag and all Velcro sail ties.

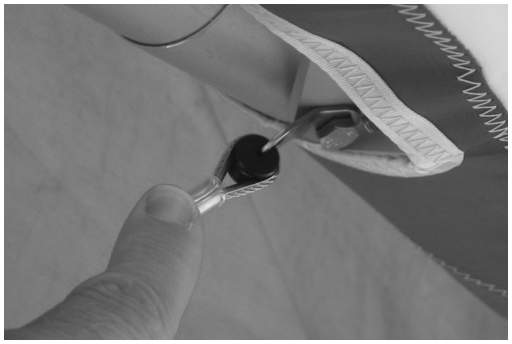
5. Spread the wings almost all the way. Raise the kingpost to a vertical position, checking to make sure that the top front and top side wires are not wrapped around the kingpost.

6. Attach the bridle ring to the snap hook at this time, taking care that there is not a twist or rotation in the bridle ring which causes the bridle lines to cross over one another.

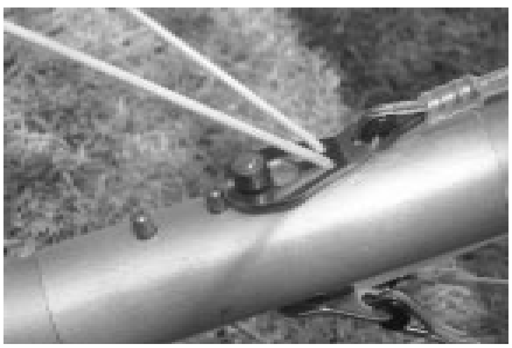



7. Lay out the battens and check each batten for symmetry against the corresponding batten from the other wing. Wills Wing convention is that *black tipped battens go in the right wing and white tipped battens in the left*, except for the straight #1 plug-on battens which may both have the same color tips.

8. Install the three longest cambered top surface battens on each side in the sail. Order of insertion is longest to shortest, from the root out. Do not install the securing strings on the rear at this time.
9. Spread the wings all the way and check all cables for any twisted thimbles or tangled cables.

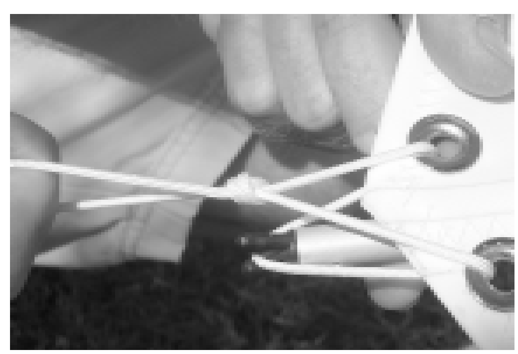



10. At the rear of the keel, tension the crossbar by pulling on the rope loop which is attached to the sweep wire keyhole tang. Drop the keyhole tang all the way down over the top portion of the keyhole collar, and let it slide forward into the locked position. The button lock should snap up into place behind the rear end of the tang. Next attach the keyhole tang for the top rear wire, and again verify that the button lock snaps into place behind it.

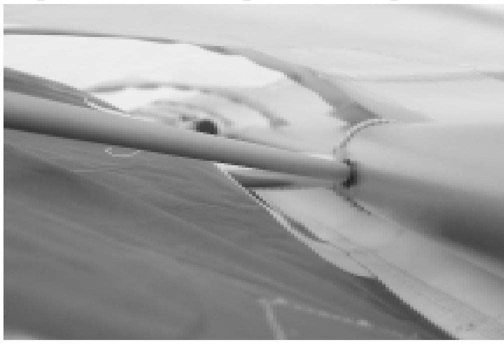



Never install the keyhole tangs onto the keyhole collar without making absolutely sure that they are fully engaged on the narrow neck of the collar and slid forward into the fully locked position. An in-flight disengagement of this attachment will cause a complete loss of structural support of the glider and a total loss of control.

11. Remove the tip cover bags. Install the washout tips by plugging them straight into the receptacles in the back side of the leading edge tube near the tip. Make sure that they are inserted as far as they will go and that there is tension on the bungee holding them in place.
12. Install the remaining cambered battens, and secure all of the cambered battens with a double loop of battens string.

13. Insert the straight #1 battens through the loop of 505 cord and between the top and bottom sail surface at the tip, and plug the forked batten tip onto the stud on the back side of the leading edge tube. Secure the batten with a double loop of the 505 cord. The tension on the #1 batten cord should be firm, but not so tight that is slackens the sail mount webbing at the leading edge sail mount endcap. If the #1 batten cord is too tight it will make the glider less responsive to turn input at slow speeds, and more likely to enter a spin from a stalled turn.



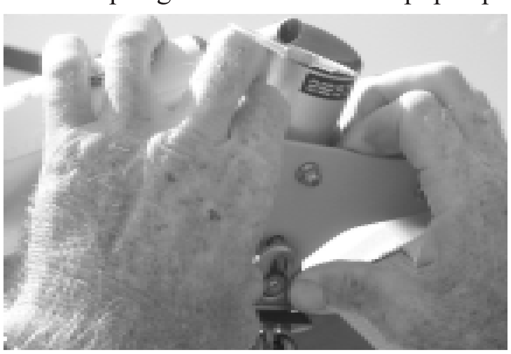
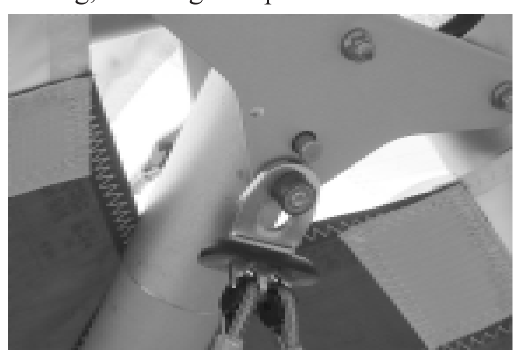

14. At this time preflight the following from the open end of the wingtip:

    a. The sail mount webbing - make sure that the inner loop of webbing is laying flat in the bottom of the slot in the sail mount endcap.

    b. The number one batten engagement on the clevis pin.

    c. The safety ring on the clevis pin that secures the front end of the rear leading edge tube

15. Go to the nose and attach the keyhole tang securing the bottom front wires, by pulling down on the nose of the glider while pressing the tang upwards over the shouldered bolt. (Remember it is the pulling down of the glider's nose rather than the upward pressure on the tang that allows you to install the tang over the bolt. If you have difficulty installing the tang, and no wires are twisted or thimbles cocked, it is probably because the glider is not sitting on level ground.) Make sure that the spring loaded button lock pops up behind the tang, securing it in place.

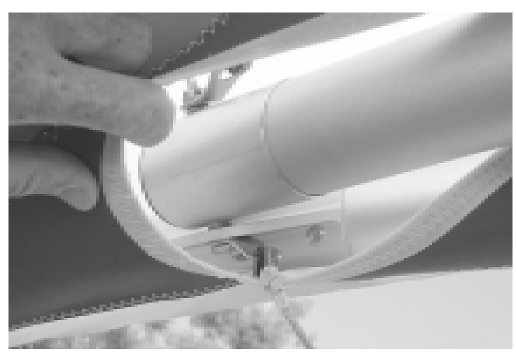
16. Push the nose batten fully back into the sail and lift the open end of the batten onto the stud on the top of the keel. Look into the noseplate and preflight the top front wire. Preflight each of the lockuts on the bottom of the noseplate - make sure they are tight, and that the bolt extends at least one full thread beyond the nut.

16. Conduct a complete preflight of the glider, according to the following procedure, checking all assemblies which have not already been checked. Every bolt, nut, pin, safety ring, and fastener of any kind should be checked during every pre-flight. A full pre-flight inspection should precede every flight you make, not just the first flight of the day.

Along the left leading edge

Check that the mylar insert is lying flat in the mylar pocket, and that it is not severely creased or buckled. A sharp crease in the mylar insert could cause a premature stall, or stall hysteresis (delayed stall recovery) that can adversely affect both handling and performance.

Check the nut which secures the leading edge crossbar bracket to the leading edge, and check the nut and the white nylon threaded nut cap which secure the crossbar to the bracket. On the Alpha 210, the top side wires are secured to the crossbar by a separate bolt, inboard of the crossbar / leading edge junction – check this assembly as well. Check that the sail is not caught on the crossbar end, nor on any of the hardware.



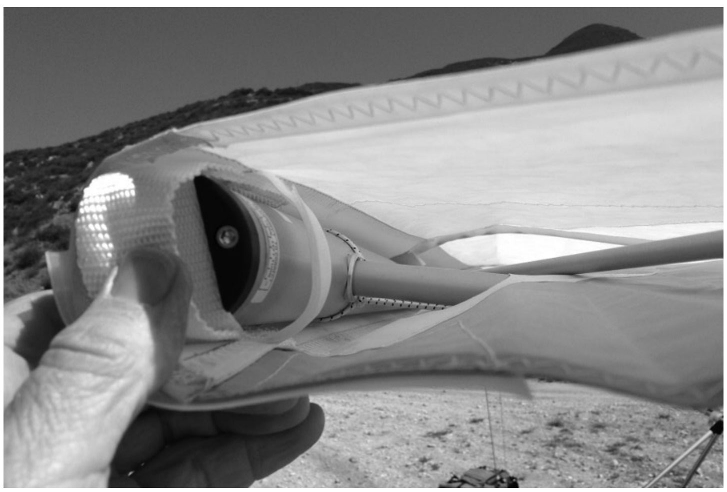
Check that there are no cocked thimbles on either end of either bottom side wire, or on the crossbar end of the top side wire.

While pushing up on the leading edge between the nose and the crossbar junction, step on the bottom side wire with about 75 lbs. of force. This is a rough field test of the structural security of the side wire loop, the control bar, the kingpost, and the crossbar, and will likely reveal a major structural defect that could cause an in-flight failure in normal operation.

At the left wingtip

Check the proper installation of the number one batten, and the sail mount webbing.

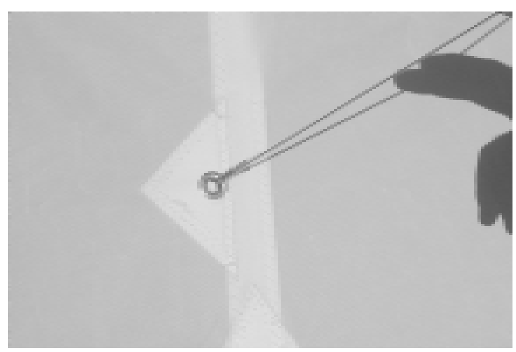


Along the trailing edge, left wing

Check that there are no tears in the sail material along the trailing edge.

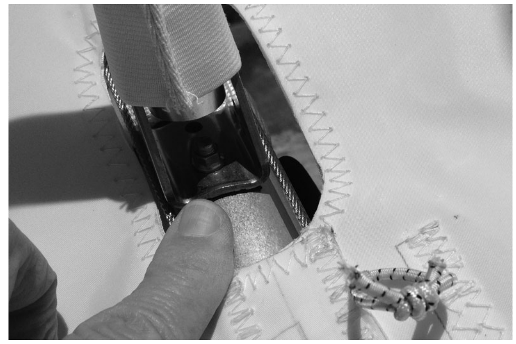
Check that all batten strings are secured

Check that the bridles are properly engaged, with the plastic retainer balls fully seated against the grommet and that no bridle cable is hooked underneath a more inboard batten.

From the rear keel

Check the nut on the top of the kingpost base bracket which secures the bracket to the keel.



Check the condition of the sweep wires in the vicinity of the kingpost base bracket.

Check the kingpost top for proper attachment and routing of the bridles and condition of the top rear wire and bridle pigtail wire.

Check again that the keyhole tangs are fully engaged on the keyhole collar and that the button lock is properly engaged.

Check that the bolt securing the bottom rear wires is fully engaged in the nut in the keyhole collar, and that the collar is securely fastened.

Along the trailing edge, right wing

Same as for left wing.

At the right tip

Same as for left tip.

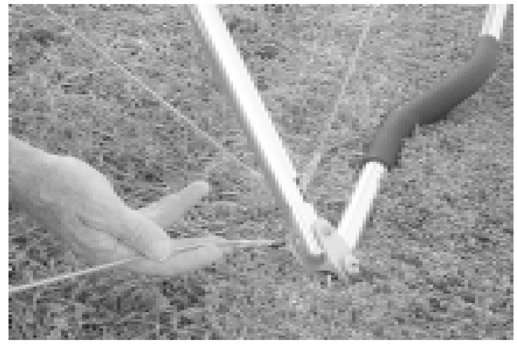
Along the right leading edge

Same as for left leading edge.

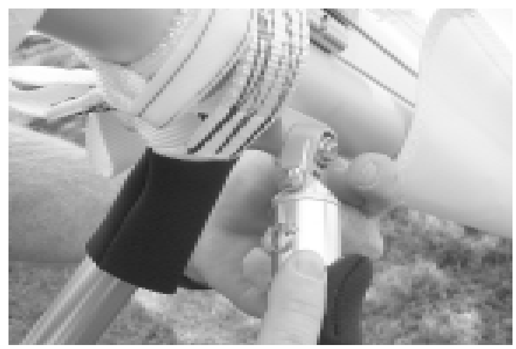
Under the glider, at the control bar

Sight down the downtubes, making sure that they are straight.

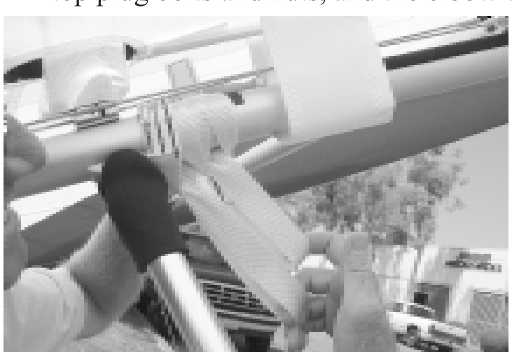
Check the cables at the control bar corners, making sure that all six cables are properly secured and that there are no kinks or twisted thimbles. Check for proper installation of all bolts, nuts, pins and safety rings at the control bar corners.

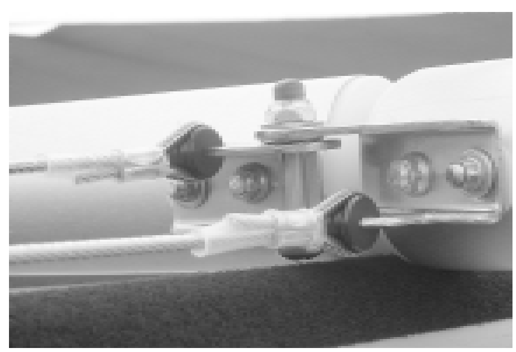


Make sure that the basetube is fully inserted into the basetube end bracket and is actually secured by the installed bolt.



Check the control bar apex bracket hardware, including the clevis pin safeties, the control bar top plug bolts and nuts, and the elbow to apex bracket nut and bolt.





Check the main and backup hang loops, that they are properly installed in the proper position and that they are in good condition.

Check the attachment of the sweep wire to the crossbar, and the center hinge bolt and nut.

At the nose

Check the security of all nuts at the noseplate, and check the top front wire. Check that the keyhole tang safety is properly secured and that the button lock is in place.

Laying the glider down flat

The Alpha is not designed to be laid flat on the ground with the crossbar tensioned, nor is it designed to be set up flat on the ground.

Launching And Flying The Alpha

1. If the wind is more than 10 mph or gusty you should have an assistant on your nose wires on launch, and, if necessary, an assistant on one or both side wires. Make sure all signals are clearly understood. Do a hang check immediately prior to launch. The angle at which you hold the glider should depend on the wind speed and slope of the terrain at launch; you want to achieve a slight positive angle of attack at the start of your run.
2. Run aggressively on launch and ease the bar out for lift off.
3. The flying characteristics of the Alpha are typical of a single surface flex wing. Make your first flights from a familiar site in mellow conditions to give you time to become accustomed to the glider.
4. We recommend that you hang as close as possible to the basetube in the glider - this will give you lighter control pressures and better control.

Using Wing Tufts

Your Wills Wing glider has been equipped from the factory with short yarn tufts on the top surface of each wing. The shadow of these tufts will be visible through the sail. The tufts are useful for indicating the local reversal of the airflow which is associated with the onset of the stall in that portion of the wing. You can use these tufts, as described below, to help determine when you are flying at minimum sink airspeed.

There are two important airspeeds with which all hang glider pilots should be intimately familiar; minimum sink airspeed (hereinafter referred to as VMS) and minimum controllable airspeed (MCA). **The most important of these two is MCA**. Minimum sink airspeed is that speed at which your descent rate is the slowest possible. It is the speed to fly when you want to maximize your climb rate in lift, or slow your rate of descent to a minimum in non lifting air. (You would normally not fly at VMS in sinking air; the strategy there is normally to speed up and fly quickly out of the sink. By minimizing your time spent in the sinking air you minimize altitude lost, even though you have momentarily increased your sink rate by speeding up.)

Minimum controllable airspeed is that speed below which you begin to rapidly lose effective lateral control of the glider. Recognition of this speed and its implications is a more subtle problem than many pilots realize. We have seen several instances of pilots who were having a lot of trouble flying their gliders simply because they were unknowingly trying to fly them too slowly; below the speed at which the glider responded effectively to lateral control inputs. It is our opinion that a great percentage of hang gliding accidents are caused by inadvertent flight below MCA, and subsequent loss of control of the glider with impact preceding recovery. Such incidents are usually attributed to “stalls,” but it is not the stall per se that causes the problem, indeed the glider need not even be “stalled” in the traditional sense.

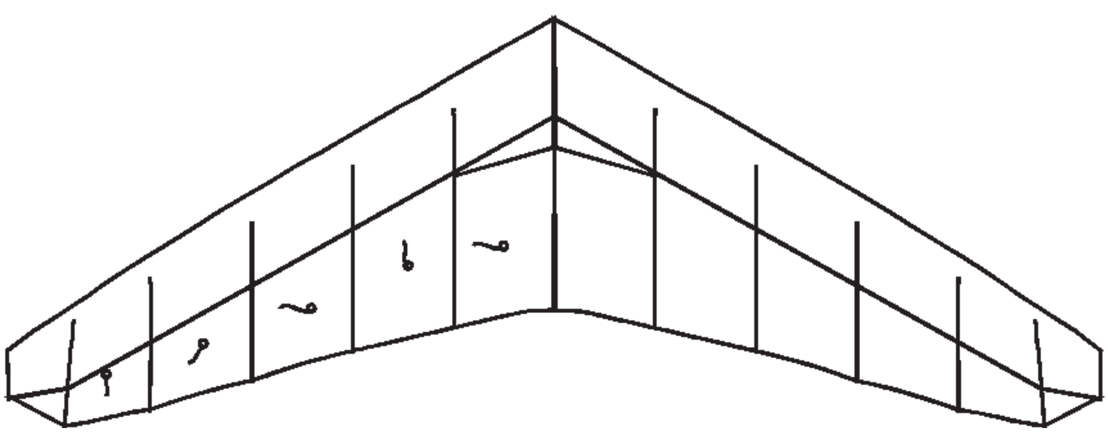
There is no necessary cause and effect relationship between minimum sink speed and minimum controllable airspeed. VMS is determined primarily by the wing loading and span loading, the wing planform, the wing section characteristics, etc. MCA is influenced most heavily by the tension in the sail; how much "billow" the glider has. However, in your Wills Wing glider, as in most hang gliders, MCA and VMS evolved towards a common value during the design and development of the glider. This is so because if the wing is tuned so tight that minimum controllable airspeed is at a higher speed than minimum sink speed, then effective sink rate performance can be improved by loosening the wing so as to lower the minimum controllable airspeed. Conversely, if minimum controllable airspeed is reached at a speed below that of minimum sink, the wing can usually be tightened so as to improve glide performance without significant sacrifice in other areas.

Using wing tufts to find the minimum sink speed of your glider

On a flex wing hang glider, the wing experiences a gradual and progressive stall, and different spanwise stations of the wing stall at different angles of attack. Contrary to popular belief, a hang glider wing usually does not stall first in the root or center section. It is true that because of wing twist the root section is at the highest angle of attack relative to the remote free stream airflow, but other factors influence the stall propagation on the wing. Specifically, a flex wing hang glider usually stalls first somewhere outboard of the root on each wing, approximately one fifth to one third of the way out from the root to the tip, in the area where your tufts are located. As the angle of attack is raised further, the stall propagates both outward towards the tips and inward towards the root. If you wish to observe the stall propagation across the whole wing on your glider, you can cut some more tufts from knitting yarn, about 3-4" long, and tape these to the top surface of your sail across the rest of the span.

During normal flight the flow will be chordwise along the wing, and the tufts will point towards the trailing edge. When the wing stalls, the tufts will reverse direction, indicating the local flow towards the leading edge.

At the first onset of stall, the tufts will indicate the impending separation by first wiggling, and then deflecting spanwise, before they fully reverse and point forward. The first onset of stall occurs well before the familiar "stall break" in which the glider pitches uncontrollably nose down to recover from the stall. By the time the stall break occurs, all tufts but those farthest outboard and those farthest inboard will have indicated reversed flow.



The first onset of midspan stall as indicated by the first tickling of the tufts indicates that you have reached the angle of attack corresponding to the glider's minimum sink airspeed. This will also be very close to the glider's minimum controllable airspeed. To find the glider's minimum sink speed, fly the glider in smooth air, early in the morning or late in the afternoon. When you are well away from the terrain, and well clear of other aircraft, look up at the wing tufts while you very gradually reduce the speed of the glider. Note the speed at which the first tuft first begins to wiggle just prior to blowing spanwise toward the tip. (If the tufts contain static electricity, they may not show this lateral wiggle prior to reversal. However, you may get other clues to the beginning of separation, such as slight flutter or rumble in the top surface of the sail.) This is your speed for minimum sink rate. Familiarize yourself with the position of the control bar relative to your body at this speed, with the sound and feel of the wind, with the reading on your airspeed indicator, and with the feel of the glider in terms of pitch and roll pressures. Most of the time when you are flying it will not be practical to look up for extended periods of time at your tufts. That is why familiarization with these other, more accessible indicators is important.

After finding your minimum sink speed, experiment with roll control response at speeds just above and just below this speed to find the value of MCA and the corresponding bar position and other indicators for this speed. Realize that your effective MCA is going to be higher and higher as the air becomes more and more turbulent; control response that is perfectly adequate in smooth air will not be good enough in rougher air. Try flying the glider with the midspan tufts fully reversed; you will probably find that the glider is somewhat controllable, but only with a lot of physical effort. Note that both MCA and VMS come well before the glider actually “stalls” in the traditional sense, i.e. pitches uncontrollably nose down. You may also be able to sense, or your vario may tell you that although the glider has not “stalled” (pitched nose down) your sink rate has increased significantly. In this mode the glider is “mushing.”

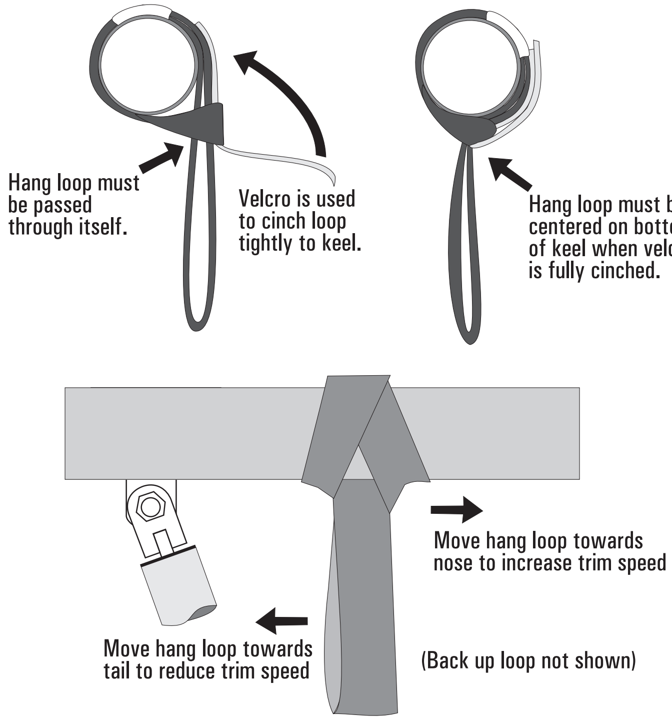
Once you have familiarized yourself with the glider’s characteristics in this range of speeds, you will not need to look at the tufts very often. You will know from bar position and bar pressure, and from the sound and feel of the relative wind when you are at your minimum sink / minimum controllable airspeed. In general, you should not fly your glider below this speed. Be aware, however, that when you are flying at minimum sink in thermal gusts and turbulence, you will experience gust induced separation of the airflow which will periodically cause the tufts on your sail to reverse.

Of course in a turn, your minimum sink *speed* goes up because you are banked, and the bank effectively increases your wing loading which increases your flying *speed* for any angle of attack. But note this: *The tufts indicate angle of attack, without regard to airspeed!* Therefore, if you practice flying various bank angles in smooth air (while well away from any terrain or other gliders) and watch your tufts (on the inside wing, which will be at the highest angle of attack) you will get a feel for the way your minimum sink speed varies at varying bank angles.

One final caution: from time to time a tuft may to stick completely to the sail, and fail to properly indicate the direction of local flow. This may result from static buildup, or from the fine threads of the yard becoming caught on a seam or some dirt or imperfection in the sail. The tuft may stick while indicating normal flow, but most often it will stick after having reversed, such that the tuft will indicate a stalled condition that does not exist. One clue in this situation is to note whether or not the tuft is wiggling. Since flow reversal occurs during a turbulent separated flow, a reversed tuft should be wiggling rapidly. If it is not, it is probably stuck. A tuft indicating normal flow will not usually wiggle. An occasional application of silicone spray to the tufts, and making sure that they are positioned so that they cannot catch on any seam will minimize the problem of sticking.

Trimming Your Glider In Pitch

The fore and aft location along the keel of your hang point is commonly (if mistakenly) referred to as your "CG location." The location of this hang point will, all other things being equal, determine at what angle of attack and airspeed your glider will naturally tend to fly (or trim), and therefore how much bar pressure there is to pull in from trim to a given faster speed, or how much pressure there is to push out from trim to a given slower speed. The farther forward your hang point is, the faster the glider will trim, the less effort will be required to fly fast, and the more effort will be required to fly slow. The ALPHA performs best at speeds relatively close to VMS, however you will have noticeably more response lateral control when flying 2 to three mph faster than that. Consequently we recommend that you trim the glider at least 2 mph above the speed at which your tufts indicate the beginning of spanwise flow. Hang loop fore and aft position is adjusted by loosening the velcro cinch strap on the main hang loop, re-positioning the loop as desired, and re-tightening the cinch strap. Make sure to tighten the cinch strap very securely, or the hang loop can slip in flight.



We recommend that you not stow your glider bag, or any other cargo on the glider. The practice of attaching your glider bag to the keel, for example, can drastically alter the pitch trim and static balance of your glider, and adversely affect its flying and landing characteristics. The best place to carry your glider bag or other cargo is in your harness.

In the absence of the use of tufts, it has become common for pilots to talk about bar position, or about indicated airspeed, when trying to communicate how to trim a glider properly or how to fly a glider at the proper speed for a given situation. The problem is that these methods are unreliable and inconsistent from one pilot to another even on the same glider. The angle at which your harness suspends your body in your glider has a great deal to do with your perception of the bar "position" relative to your body. Airspeed indicators vary in their indicated airspeed depending on the make of the instrument, its calibration, any installation error, etc. The use of tufts gives you an absolute first hand indication of the actual aerodynamic event associated with two critically important airspeeds on your glider. It is a potentially useful tool that may improve your flying.

Speeds To Fly And Using Your Airspeed Indicator

The top speed that can be sustained with a prone pilot in full forward position on the Alpha is between 33 and 38 mph, and the glide ratio at speeds above 25 is significantly degraded. We therefore recommend significant caution regarding flying in winds of more than 10 mph or when an extended glide through sinking air or into a head wind may be required to reach a safe landing area, or to reach the windward side of a ridge.

The optional Wills Wing Hall Airspeed Indicator has been specially designed to help you fly your Falcon at the proper speeds for optimum safety and performance.

Note: The Wills Wing Hall ASI is color coded for VNE and Va speeds of 53 mph and 46 mph respectively. The Alpha has lower VNE and Va speeds of 44 mph and 38 mph respectively. Therefore, for the Alpha, the top of the green area represents 2 mph above VNE speed, and Va speed lies within the green area

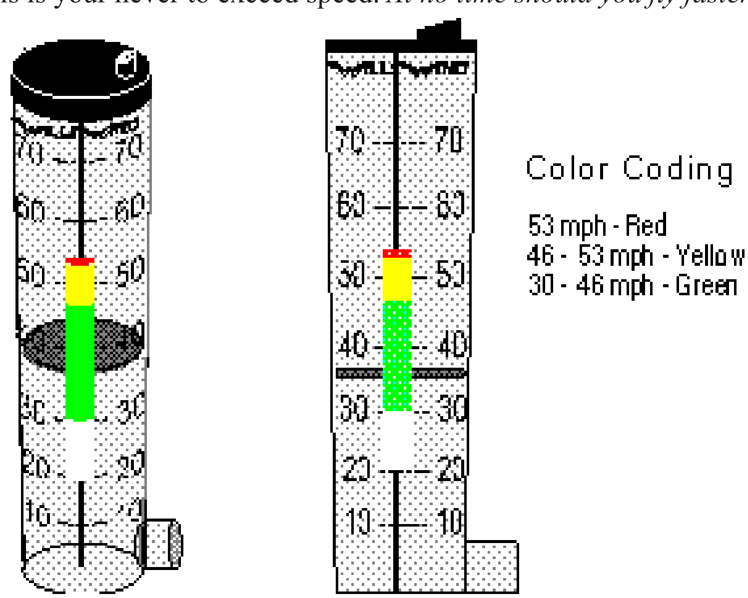
There are four color coded bands on the ASI:

White: This is the range from 20 mph to 30 mph. This is the normal flying speed range. While thermalling or flying in lift, try to keep your speed within the lower half of this range. For gliding in light sink or light headwind, you will want to fly in the upper half of this range.

Green: The top of the green region represents the placarded maximum rough air and maximum maneuvering speeds. This speed of 46 mph should not be exceeded except in smooth air, and no abrupt large control deflections should be used above this speed. In heavy sink or strong headwinds it is recommended that you keep the airspeed "in the green" for best penetration and glide ratio over the ground.

Yellow: This region represents the upper speed range between maximum rough air / maximum maneuvering speed and the speed never to exceed. You should fly in this range only in smooth air as described above.

Red Line: This is your never to exceed speed. *At no time should you fly faster than this speed.*



The design of the Hall type airspeed indicator involves using a ram air versus static pressure differential to raise a disc in a tapered tube against the force of the weight of the disc. Because of this, the ASI has the following operating limitations:

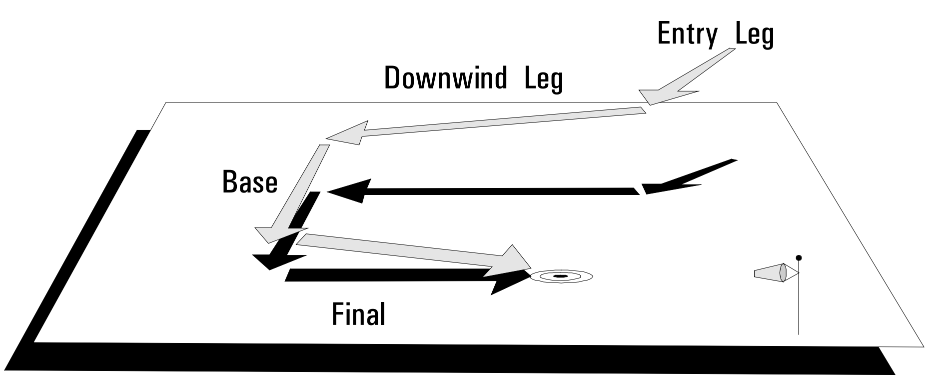
a. It is only accurate in one G flight. If you are turning at a bank angle of more than 30 degrees, the ASI will read artificially low as a result of the G loading of the turn. Reliance on the ASI for limiting airspeeds in high banked sustained spiral maneuvers will likely cause you to exceed the placarded speed limitations of the glider and will compromise your safety.

b. It is only accurate when within 15-20 degrees of the vertical orientation.

Landing The Alpha

We recommend using an aircraft landing approach (45 entry leg, downwind leg, base leg, and final leg) whenever possible, and we suggest that you practice making your approaches with as much precision as possible. Under ideal conditions, landing approaches are best done so as to include a long straight final into the wind at a speed above best L/D speed. In a very limited field, or a field which slopes slightly downhill, when landing in light wind, you may need to make your final approach at a slower speed, perhaps as slow as minimum sink, in order to be able to land within the field. In winds of less than 5 mph, if the slope is steeper than 10:1, you should seriously consider landing downwind, uphill; or crosswind, across the slope. Landing attempts which require slow speed approaches, maneuvering around obstacles or into a restricted area, or downwind or crosswind landings are not recommended for pilots below an advanced skill level.

Standard Aircraft Approach Pattern



The best way to avoid roll / yaw oscillations on approach is to fly your entire approach at a constant airspeed, and to control your touchdown point by making adjustments to the shape of your pattern. In particular, we recommend against the technique of make a diving turn onto final. This maneuver, sometimes called a "slipping turn" is often taught to student hang glider pilots as a way to lose altitude during the approach. While it will work reasonably well with low or medium performance low aspect ratio gliders which have high levels of yaw stability and damping, and which are able to lose energy by diving because of the large increase in drag at higher speeds, on a high performance glider this technique serves only to convert the energy of altitude to energy of speed, while at the same time suddenly increasing the glider's sensitivity to control inputs. The result is a high probability of overshooting the intended landing point and the prospect of roll / yaw oscillations which may interfere with a proper landing. If you develop good habits and the skills to fly precise approaches now, it will make your transition to higher performance gliders easier later on.

Once established on a straight final approach, with wings level and flying directly into the wind, you should fly the glider down to where the basetube is between three and six feet off the ground. At this altitude, let the control bar out just enough "round out" so that your descent is arrested and your flight path parallels the ground. The remainder of your approach will consist of bleeding off excess speed while paralleling the ground and keeping the wings level and the nose into the wind until it is time to "flare" for landing.

Prior to the landing flare your body position should be generally upright, but slightly inclined forward, with your head and shoulders forward of your hips and your legs and feet trailing slightly behind. Your hands should be at shoulder width and shoulder height on the uprights. You should be relaxed, with a light grip on the bar, and your weight should be fully supported in your harness and not at all by your arms. There are several options for when to make the transition from prone to this semi-upright position. Some pilots favor going upright with both hands moving to the downtubes while still at altitude prior to the start of the approach. Others transition at the start of the approach to a semi-upright position with one hand on a downtube and one hand on the basetube, and complete the transition by moving the other hand to the downtube just a few seconds prior to flare. Still others fly with both hands on the basetube until established on final glide, and then transition one hand at a time to the downtubes prior to flare.

Whichever method you use, there are a few important principles to observe. The first is that you should not make any change in hand position unless you are flying at or very near trim speed. At speeds faster than trim, you will be holding the bar in pitch against substantial force, and if you let go to move your hand the glider will pitch up and roll towards your remaining hand. The second is that while moving either hand, you have no control over the glider. You should move only one hand at a time. Even so, if you can't make the transition in the position of each hand quickly and reliably, you should transition both hands while at altitude, before you start your approach. Otherwise, if you fail to make a quick transition, you could be out of control close to the ground, and suffer a turbulence induced change in heading or attitude without sufficient time to recover. Many pilots make the mistake of trying to change position while flying fast and close to the ground, and experience a dangerous loss of control as a result. A third principle to observe is that if you are using a "pod" type harness, you should unzip and confirm that your legs are free to exit the harness at least 500 feet above the ground and before you start your approach. If there is any problem finding the zipper pull, or dealing with a stuck zipper, you don't want to have to try to fix that problem while also flying the approach.

Finally, you should not attempt to get into a fully upright body position at any time during the landing approach prior to the actual landing flare. Most modern harnesses will not allow you to hang in a fully upright position without pulling yourself up on the downtubes, and this is something you should NOT do. The mechanism by which you attain an upright position at the moment of touchdown is to execute a strong flare, which causes the glider to slow abruptly, causing you to swing forward and into a standing, upright position underneath the glider. The more upright you try to be prior to the flare, the more you move your shoulders back relative to the center of mass of your body, which effectively shortens your arms and weakens your flare authority. Keep your head and shoulders forward, and your feet and legs back, with your body in a semi upright position, until it is time to flare, and then flare from this position.

Once established on a wings level short final, into the wind, body semi-upright and with both hands on the downtubes, your final concern is the timing and execution of the landing flare. The goal is to arrive on the ground, on your feet, under control with the glider settling on your shoulders. If the wind is 15 mph or more, you will not really execute a flare at all; you will simply slow to minimum flying speed, put a foot down, and step onto the ground. In lighter winds, you will want to use some combination of a final nose up flare, and running out your landing, in order to finish the flight on your feet with the glider settling on your shoulders. The lighter the wind, the stronger should be both your flare and your run.

The traditional method of landing in light or no wind calls for a sharp, aggressive flare at precisely the correct moment. This technique works fine when done correctly, but it's not easy to get the timing just right. Flare too early and you will climb, and then fall with the nose pitching down. Flare too late and you won't get the nose up enough to stop your forward motion, and the glider may nose into the ground as you run into it from behind.

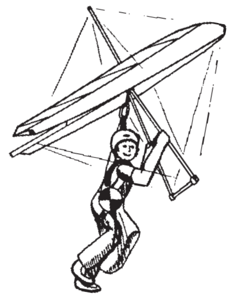
The flare timing process is made much easier by using a combination of a "crescendo flare" and a run out of the landing. As you bleed off speed on final, flying just above the ground, you are at first letting the control bar out towards its trim position. As the glider reaches trim speed, which will normally be one to three mph above stall speed, you begin to gently push the bar out to keep the glider from settling. At this point it is almost time to flare. As the glider enters the "mushing" range of angles of attack, it will begin to settle in spite of your continuing to ease the bar out. This should be happening well before your arms are significantly extended. At this point begin your flare by smoothly accelerating the rate at which you push out on the bar. At the same time, draw one leg forward, put a foot down, and start to run as hard as you can. This run should be very much like an aggressive take off run – your body should be leaning forward into the run and you should be driving with your legs. The difference here is that while you are leaning into your run and driving forward with your legs, your arms are extending fully from your shoulders, pushing out, and what feels like upwards, on the control bar in an accelerating, "crescendo" flare.

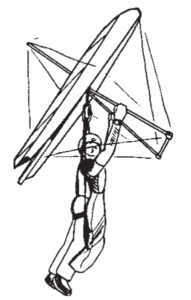
Done correctly, this type of flare / run combination will bring the glider quickly to a very nose high attitude, producing a great deal of drag and quickly arresting all of your forward motion. You will feel the glider pulling you from behind, resisting your attempt to run, and as you slow down the glider will settle gently on your shoulders. Even in no wind, you should not have to take more than a few steps. If your timing is a little early, and you feel the glider start to climb, simply stop pushing out and resume the flare when the glider again begins to settle. If your timing is a little late, your feet will touch down a little sooner, but as long as you're running and flaring at the same time, the glider will stay over your head or behind you.

If you are landing in light or no wind in an area that does not allow you to run (rocks, sagebrush, uneven ground) you will need to have mastered the full flare, zero ground speed in no wind technique. This is a little different from the abrupt flare – it is a slightly slower, but still very effective flare that starts a second (or less) earlier, before the glider has begin to settle. When properly executed, this flare will result in the glider flying a curving flight path into a slight climb, with the nose very high, and then settling near vertically to the ground. This flare requires a lot of precision in timing and execution, and it's not a technique you are likely to need flying an Alpha and landing in most normal landing areas, but it is worth learning for some future time when you might need it.

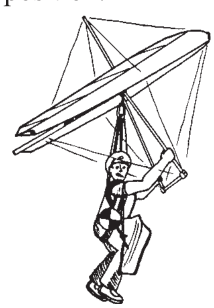
Pilots who have trouble with the flare, and with the glider nosing over during landing, usually do so because of one of the following problems:

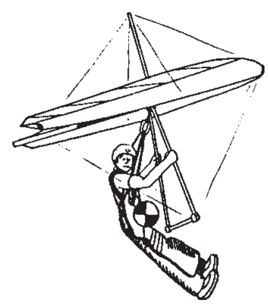
a. Harness leg straps too long / hanging too low below the glider, and / or hands too low on the control bar. This reduces pitch authority and prevents an adequate flare.





b. Improper body position - pilot leaning back, (away from the anticipated hard landing), with feet extended in front. This moves the pilot's center of mass forward ahead of his shoulders, effectively shortening the pilot's arms and reducing flare authority. The proper position is with the pilot's body inclined forward, with the shoulders out ahead of the pilot's center of mass. Thinking about pushing "up" instead of "out" when flaring may help you to maintain the proper forward inclined body position.





c. Slowing too much prior to flare, so that your arms are too extended to allow enough flare amplitude.

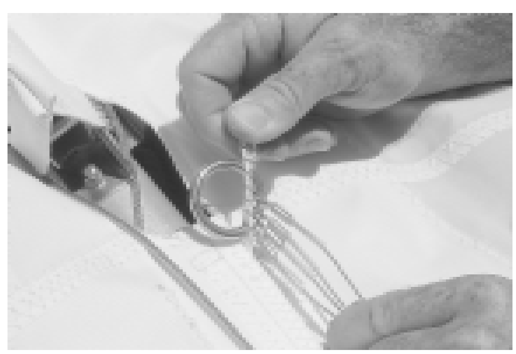
Alpha Breakdown

Breakdown of the glider is the reverse of assembly.

The outer 3 cambered battens on the Alpha can be removed with the crossbar tensioned but it's best to release the crossbar tension before removing the long inboard battens. Always remove the battens gently so as to avoid undue wear on the batten pockets or stress on the battens which may change their shape.

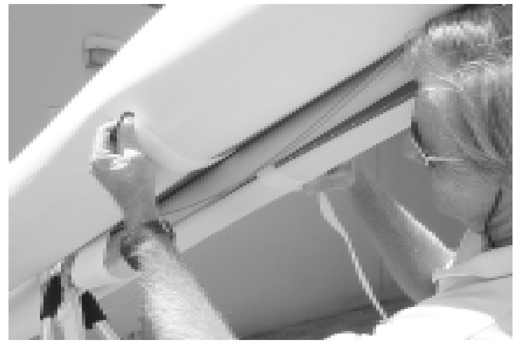
1. Set the glider at slightly more than 90 degrees to the wind direction (slightly tail wind). Dismount the nose batten, and pull it out about 2" past the noseplate. Remove the #1 battens and 2 shortest cambered battens, dismount the washout tips, roll the sail under at the tips, and install the tip cover bags over the sail and washout tips. Stow the straight number one battens in the tip bags and tighten the velcro strap on the bags.

2. Depress the keyhole button lock on the bottom of the noseplate to allow the keyhole tang to be disengaged. Disengage the tang by pulling down on the nose of the glider while pushing up with your thumbs on the plastic tang handle.
3. Depress the keyhole button lock on the rear of the keel, and disengage the top rear wire. Pull back on the crossbar sweep wire and disengage the sweep wire, de-tensioning the crossbar.
4. Remove the remainder of the battens.
5. Fold the wings together, pulling the sail up over the top of the leading edges. Work gently here, and alternate from one wing to the other, folding each wing in about 1/3 of the way at a time. Check to see that the crossbar center has not fallen down between the keel and leading edge on one side. If you meet any resistance, stop and correct the interference.



6. Detach the bridle ring from the snap hook, and lay the kingpost down forward against the keel.
7. Stow the bridle ring in the loop of bungee attached to the sail at the kingpost base. Install the neoprene kingpost cap cover.

8. Pull the sail out so that there is even tension on the top and bottom layers and roll the sail towards the keel on each side. Try to keep the mylar insert and leading edge area as smooth as possible.



9. Secure the sail with the Velcro sail ties provided, but do not apply them too tightly.

The wide, long Velcro strap is installed by passing it OVER THE TOP of the keel tube just forward of the control bar top, and then installing it around the glider leading edges. This holds the leading edges up away from the control bar apex hardware.

10. Place the glider bag on the glider, and flip the glider over onto the ground.
11. Detach the basetube, fold the control bar, and install the control bar bag and keel protective covers. (Note - The glider will fit in the bag more easily if you remove the basetube at both ends.)
12. Gather the battens so that all the cambered ends match up, put the battens in the batten bag tail-end first and cinch the velcro tie on the bag. This will make it less likely for the battens to get out of shape. Place the bag in the rear of the glider between the rear leading edges, and zip up the bag.

Alpha Stability Systems

Stability in pitch is provided by reflex in the root section, which is determined by the lengths of the kingpost, control bar, and front to rear top and bottom wires, and by the shape of the root battens, and by reflex support bridles running from the kingpost to the trailing edge at the number five, and six battens, and by washout tips installed in the leading edge underneath the number two battens.

Correct attachment and proper adjustment of the bridles are critical to providing adequate stability at low angles of attack, particularly those below the normal operating range.

Reflex Bridle Adjustment And Compensation

The glider must be fully assembled to measure the bridles. Attach a light-weight thread to the ends of each of the number five and six battens (the battens at the bridle attachment stations), run the threads over the top of the keel, and attach them to the corresponding battens on the other side. Adjust the thread so it does not sag. Measure the distance from the top surface of the keel directly under each thread to the thread. The minimum heights of the threads should be:

Model	Thread at #5 Batten	Thread at #6 Batten
Alpha 180	13.25” or 336 mm	6.25” or 158 mm
Alpha 210	15.5” or 393 mm	6.375” or 162 mm

Final proper adjustment of the bridles is determined by sighting the shadow of the bridles on the sail in flight. With the glider in a 30 degree banked turn at Vms, shake the control bar sharply and observe the shadow of the bridles according to the following criteria:

Tight	No movement in the line, the line is straight and appears under tension.
Snug	Minimal movement, no apparent curve in the line but no apparent tension.
Just Slack	The center of the bow in the line moves one to two inches either side of its rest position. Some apparent curve in the line may be seen without shaking the bar.
Slack	The center of the bow in the line moves two to four inches either side of its rest position. Definite slack in the line can be seen without shaking the bar.
Quite Slack	The center of the bow in the line moves four or more inches either side of its rest position. Slack in the line can be easily seen without shaking the bar.

The bridles are properly adjusted when they sight between just slack and slack in the above test. Adjustment of the bridles requires replacing the bridle pigtail with one of a shorter (to tighten) or longer (to loosen) length, or shimming the bridles from underneath the trailing edge.

Improper adjustment of the bridles will affect the glider's pitch stability and flight characteristics in the following ways:

Bridles too loose

If the bridles are adjusted too loose, it will not affect the glider in normal flight as the bridles are always slack in this range anyway. At angles of attack below normal flight, there will be a reduction in pitch stability proportional to the amount by which the bridles are looser than they are supposed to be. This stability reduction could increase the probability of a turbulence induced tumble or other in-flight stability related loss of control.

Bridles too tight

If the bridles are adjusted too tight, it will compromise the flight characteristics of the glider. The effects of too tight bridles are to increase roll control pressures and reduce roll rate in circumstances where maximum control input is applied.

Other factors of glider geometry which affect bridle adjustment and effectiveness

The effective adjustment of the bridles is also affected by other aspects of the glider geometry. For example, if the bottom side wires are too long, it will allow the wings to rise and slacken the bridles in normal flight. If they are too short, it will pull the wings down, and tighten the bridles in normal flight.

If the top side wires are too short, it will reduce the amount the wings can "fold" downwards as the glider unloads at low angles of attack, thereby reducing the effectiveness of the bridles.

Changes from proper length to the top or bottom side wires will also change the relative adjustment of the inner and outer bridles to each other, and change the way they operate.

Maintenance Schedule

You should continually maintain your glider in a proper state of tune and repair to insure optimum airworthiness, performance and flight characteristics. Failure to properly maintain your glider may lead to a dangerous loss of strength, stability or control responsiveness of the glider. Following any mishap that results in damage to the glider immediately have any damaged component repaired or replaced. We recommend that you have all such maintenance work done by your Wills Wing dealer. In addition, please follow the following maintenance schedule.

Every month or every 30 flights

1. Spray all battens with Sailkote spray lubricant as you install them in the glider to lubricate the insides of the batten pockets. Do not use any other type of lubricant. Wipe off any excess lubricant so that it does not attract dirt. If you fly in a dusty or sandy environment, it will help to prolong the life of your batten pockets if you wipe each batten with a rag before you install it in the sail.
2. Check your battens on a flat level surface following the instructions on the batten diagram provided, and correct any that deviate from the pattern in accordance with the instructions.

Every six months or every 150 flights

1. Have a complete inspection performed on the glider and replace any component that shows any wear, and any cable that shows any kinks, wear, damage, corrosion, etc.
2. Inspect all bolts for tightness, all safeties for proper installation and possible damage. Inspect plates and fittings for damage, holes in tubes for elongation.
3. Inspect the sail for wear, tears, UV damage, loose stitching, etc.

Every twelve months or every 300 flights

1. Have the sail completely removed from the frame, and disassemble all frame components. Inspect every part of the glider for any damage or wear. Inspect the tubes for straightness and for signs of corrosion. Anytime you have the sail off the frame inspect all of the batten pockets and batten pocket terminations.
2. Replace bottom side wires and hang loops.

Special circumstances

1. Any time you suffer a crash or extremely hard landing you should have an “annual” inspection done on your glider to insure that you find all damaged parts. If you bend a downtube, carefully inspect all hardware at the top and bottom of the control bar for damage.
2. If your glider is ever exposed to salt water you will need to have the glider completely disassembled in accordance with the recommended annual inspection procedure. All frame parts will need to be disassembled, including the removal of all sleeves, flushed liberally with fresh water, dried completely, and treated for corrosion inhibition with LPS-3 or other suitable agent.
3. Cleaning Your Sail - Keeping your sail clean will extend the life of the cloth, however cleaning the sail too often, or scrubbing the sail excessively will accelerate the breakdown of the stabilizing resin in the cloth, and shorten the life of the sail. When cleaning the entire sail you should generally use only water and a soft brush. You may clean small spots or stains with any commer-

cial spot remover that is labeled for use on polyester. Such cleaning agents are available at the supermarket or drug store, or you may order a cleaning solution from Wills Wing through your dealer.

A note about cables and cable maintenance:

The cables which support the glider's airframe are critical components of the glider's structure, and must be maintained in an air worthy condition. It is a general practice in the design of aircraft structures to design to an ultimate strength of 1.5 times the highest expected load in normal service. Hang glider cables, like other structural components on the glider, are typically designed with a structural safety factor of only about 50% above the expected maximum load. No significant loss in cable strength can be tolerated.

A cable with even a single broken strand must be replaced before the glider is flown again. A cable which has been bent sharply enough to have taken a permanent set (will not lie flat in a straight line when all tension is removed) must also be replaced immediately. If it is not, subsequent tensioning and de-tensioning of the cable will induce fatigue, and the cable will fail. In tests we have conducted, a cable bent one time to 90 degrees, and then loaded to the equivalent of a normal flight load 100 times (corresponding to 100 or fewer flights), failed at only 56% of its original strength.

Some degree of fatigue due to repeated bending of cables is almost unavoidable in an aircraft that is assembled and disassembled with every flight. Bottom side wires are subject to the highest loads in flight, and are therefore the most critical. This is why we recommend that these wires be replaced annually, even if there is no known damage. The requirement for immediate replacement of a cable known to have been bent or otherwise damaged supercedes this annual replacement requirement.

Replacement cables should always be obtained from the factory, or, if not from the factory, from a reliable source known to use proper fabrication procedures. An improperly made cable may appear perfectly OK on visual inspection, but could fail in flight at a load much below the intended design strength of the cable. Even if the replacement cable is obtained from the factory, it should be checked carefully for length against the cable it is replacing, and inspected carefully before being installed.

Removing The Sail From The Airframe And Re-installing

Many maintenance and repair procedures will require the removal of the sail from the frame. Please follow these instructions when removing and re-installing the sail. Please read all the instructions for each operation before beginning.

Sail removal

You will need an unobstructed area six feet by thirty feet. Make sure the surface is clean. If it is abrasive, like rough concrete, you should either put down a protective tarp or be extremely careful not to scrape your sail.

1. Lay the glider on its back, unzip and remove the glider bag and put the battens aside. Remove the control bar bag.
2. Remove the screws that secure the sail at the nose. Spread the wings slightly, undo the velcro tabs inside the rear ends of the leading edges and then dismount the sail from the rear leading edges.

Tape the sail plugs in position on the leading edges so that they do not become switched side to side inadvertently.

3. Unbolt the bottom side wires from the control bar. Remove the clevis pin which secures the control top elbows to the apex bracket. Unbolt the bottom rear flying wires from the rear keel. Re-assemble the hardware removed onto the bolts in the original order so that it doesn't get lost. All disassembled assemblies on the glider must be re-assembled in the proper order and orientation. Use the exploded parts diagrams in this manual to help you. On the bottom rear wire, the relative position of the washers, saddles and tangs affects the front to rear wire tension.
4. Set the control bar aside.
5. Turn the glider over. Unroll the sail until you can reach the bridle attachments at the trailing edge. Remove the plastic bridle retainer balls and disconnect the bridles from the sail.
6. Remove the screw that holds the kingpost top cap in place and carefully remove the cap. Remove the top front and top side wires from the kingpost top. Re-install the cap. Unbolt the kingpost from the keel. Set the kingpost aside.
7. Feed the top and bottom side wires into the sail through the holes in the sail. Turn the glider over onto its back again. Disassemble the crossbar center section, and fold the crossbar halves to the rear to align with the leading edges. Slide the frame out through the nose of the glider. If you encounter resistance, stop and find out what is hanging up.
9. If you need to send the sail into the factory for repair, fold and package the sail carefully. Be sure to include written instructions of what you want done, your name and a phone number where you can be reached during the day.

Reinstalling the sail on the frame

1. Position the sail on the floor with the keel pocket up and the wings folded over so that the leading edges lie along the length of the root line, with the top of the leading edge lying on top.
2. Prepare the frame, making sure that the side wires are pulled forward from the crossbar leading edge junction and are not wrapped around the frame. The crossbar halves should be separate, and swung aft to be aligned with the leading edges.
3. Position the frame with the bottom of the noseplate facing up and with the rear end of the leading edges at the nose of the sail. Slide the frame into the nose of the sail, making sure that the leading edges of the frame and the crossbar halves pass properly into the leading edge pockets of the sail and don't get caught at the rear of the bottom surface near the root. As you feed the frame slowly into the sail, check periodically to see that none of the hardware is snagging on the sail. As the crossbar ends reach the leading edge junction cut outs in the sail, bring them out through these holes.
4. After the frame is fully installed, mount the webbing anchor loops over the rear leading edge end-caps. Make sure you mount the inner webbing loops in the endcap slots, not the outer "handle" loops! Make sure that the webbing lies flat and smooth in the slot, and that the sail is properly aligned when mounted. Secure the velcro retainer tabs.
5. Working through the crossbar cut out hole, insert the top wires through the holes in the sail, making sure that no cable is wrapped around a leading edge or crossbar, and that no thimbles are cocked or twisted. Pull the bottom side wires out through the crossbar cut out hole.

6. Bolt the bottom rear wires to the rear of the keel attaching the rear sail mount at the same time. Install the control bar onto the apex bracket, and attach the bottom side wires to the control bar corners.
7. Flip the glider up onto the control bar. Working through the nose, insert the top front wire up through the hole in the sail.
8. Re-install all the top wires onto the kingpost.
9. Spread the wings slowly and carefully, making sure that the sail rides forward as necessary at the nose without catching. Be careful: you can easily tear the sail open at the nose at this point. Re-install the nose screws after the sail is fully spread.
10. Bolt the kingpost bracket to the keel. Connect the top rear wire, and the bottom front wires. Connect the bridles to the sail.
11. Finish the assembly of the glider completely according to normal assembly procedures.
12. Do a very careful and complete pre-flight of the glider according to the normal pre-flight procedure as explained earlier in this manual.

Tuning

Dismounting and remounting the sail at the tip

A number of tuning procedures require you to dismount the sail at the rear leading edge. This is most easily done with all of the battens removed from the sail, the crossbar de-tensioned, and the wings spread approximately 1/3 of the way. You will first need to disengage the Velcro attachments that wrap around the rear of the leading edge tube. Then, pull straight aft on the handle portion of the sail mount webbing to disengage it from the slot in the endcap. If necessary, you can use a large, flat bladed screw driver to pry the sail mount webbing off of the end of the leading edge, but take care not to damage the webbing in the process. The same technique can be used to re-install the sail. When remounting the sail, be sure to mount the inner webbing in the slot, not the outer handle webbing, and be sure that the webbing seats squarely in the slot.

CG adjustment

has already been covered in the section of this manual on using your wing tufts. Wills Wing recommends that tuning other than CG adjustment be performed by your Wills Wing dealer.

Turn trim

Turns are caused by an asymmetry in the glider. If you have a turn, first try to make the glider symmetrical in every way.

Airframe

Check the leading edges for possible bent tubes. Check that the keel is not bent to one side.

Check for symmetrical twist in the leading edges by checking for symmetry in the alignment of the sail mount plugs.

Battens

Check the battens for symmetrical shape and batten string tension.

Sail mount plugs - adjusting sail tension and rotational alignment

The molded plastic sail mount plug fits directly into the rear leading edge. It is secured against rotation by a sliding wedge which is forced out against the inside of the tube as the Allen screw is tightened. The proper installation procedure for this plug is to engage the allen screw three turns into the sliding wedge, install the plug into the rear leading edge, set the desired alignment, and then tighten the allen screw 9 additional turns.

Shims are added to the allen screw type plug by sliding them over the end of the plug before the plug is inserted into the leading edge. The shims are thus visible with the plug installed.

Once the allen screw type plug is installed, the rotational alignment can be changed by loosening the allen screw to relieve the pressure of the wedge against the inside of the leading edge tube until the sail mount plug is free enough that it can be rotated.

If you loosen the screw too much, the wedge will fall off inside the leading edge tube, and you will have to dismount the sail to retrieve it.

Sail tension

Check for symmetrical sail tension on the leading edges. In order to check this, remove the sail mount screws at the nose, detension and re-tension the xbar and sight the hem of the sail at the bottom of the leading edge tube relative to the noseplate on each side. Sail tension is adjusted by adding or removing shims in 1/8" or 1/4" increments to or from the sail mount plugs on the rear ends of the leading edges. See the discussion above about the different types of sail mount plugs and how shims are added or removed.

To remove or add shims from either plug, first dismount the sail mount webbing by pulling it free and then to the outside of the leading edge. You can use a flat bladed screwdriver to pry the webbing off, but take care not to damage the webbing. After dismounting the sail, first check and record the rotational alignment by noting the position of the scribe mark on the plug relative to the scale on the leading edge tube. Use the allen wrench provided in your spare parts kit to loosen the allen screw until you can remove the plug. Add or remove shims as necessary, and then reinstall the plug, making sure the alignment is correct. Nine turns of the allen screw after installation of the plug will secure the plug in place.

Make sure to replace the sail mount screws at the nose.

Twisting a tip

After you have made everything symmetrical, if you still have a turn, you will correct it by rotating one or both sail mount plugs. A left turn is corrected by twisting the left sail plug clockwise (twisting the sail down at the trailing edge) or twisting the right sail plug clockwise (twisting the sail up at the trailing edge) or both. Twist counter clockwise on either or both plugs to correct a right turn.

To rotate the sail plug, use the allen wrench provided in your spare parts kit to loosen the allen screw thus pushing the wedge forward and releasing the plug.

If you loosen the screw too much, the wedge will fall off the end of the screw inside the leading edge, and you will have to dismount the sail to retrieve it. Start by loosening the screw ten turns, and then check to see if you can rotate it. If not, loosen it one turn at a time until it can be rotated.

After rotating the plug in the desired amount in the desired direction, (see above) tighten the screw to secure the plug against rotation. When the screw is properly tightened, there will be a slight bulge (less than the wall thickness of the tube) in the rear leading edge tube adjacent to the screw.

Adjusting batten tension

All battens are tensioned by looping the batten string over the notched end of the batten twice. The inboard batten strings should be slightly on the loose side, and the outboard batten strings should be progressively tighter. The number one batten strings should be firm, but not so tight as to slacken the sail mount webbing which mounts the sail at the tip.

Leading edge sail tension

The tension in the leading edge of the sail, adjustable by shimming as described above, will influence the performance and handling of the glider. If the sail is mounted too loose, the performance will deteriorate noticeably. If the sail is mounted too tight, the glider will handle poorly; it will be stiff and slow in roll response with excessive adverse yaw and an increased tendency to spin in a stalled turn. As the glider gets older and the sail stretches, you may need to add shims to maintain the proper tension. Please note that adding shims may reduce the speed at which trailing edge sail flutter begins.

Car Top Mounting And Transport

Improper or careless transport of your glider can cause significant damage. You should transport your glider on a rack which has at least three support points which span at least 13' of the length of the glider. These should be well padded and at least four inches wide to distribute the load. Your glider should be mounted on your rack with the control bar facing up. It should be securely tied down with webbing straps which are at least 1/2" wide If you drive on rough roads where the glider receives impact loads, you should take extra care to pad your glider internally when you pack it up. One special area to pay attention to is the forward area of the glider where the crossbar center section bears against the top of the leading edge tubes, and the kingpost sits on top of the keel. Some extra padding inserted in this area will save wear on your airframe and sail.

We specifically recommend against transporting your glider inside a tube or box, unless the glider rests on a well padded surface and is secured inside the tube or box against movement. We have seen many examples of gliders transported inside tubes or boxes that underwent highly accelerated wear or suffered damage, including the fatigue failure of critical hardware compenents, due to the continuous, high frequency movement of the glider when driving over normal bumps in the road surface.

In Closing

With proper care and maintenance, your glider will retain a high level of airworthiness for some years. Because of the relatively short history of hang gliding, and the rapid advances in new designs, we do not have a lot of information about the ultimate service life of a hang glider. We do know that ultraviolet (UV) damage to the sail from sunlight is probably the limiting factor in the life of your sail. Try to avoid exposing your sail to sunlight any time you are not actually flying it.

We also know that there are forces in nature which can be so violent that they can result in fatal accidents regardless of the airworthiness of your aircraft. Ultimately your safety is your responsibility. Know the limitations of your knowledge, skill and experience, and know the limitations of your aircraft. Fly within those limitations.

Have fun.

See you in the sky!

Wills Wing, Inc.

HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL Alpha 180

MANUFACTURED BY Wills Wing Inc.

All dimensions in inches; weights in pounds.

NOTE: These specifications are intended only as a guideline for determining whether a given glider is a certified model and whether it is in the certified configuration.

Be aware, however, that no set of specifications, however detailed, can guarantee the ability to determine whether a glider is the same model, or is in the same configuration as was certified, or has those performance, stability, and structural characteristics required by the certification standards. An owner's manual is required to be delivered with each HGMA certified glider, and it is required that it contain additional airworthiness information.

1. Weight of glider with all essential parts and without coverbags and nonessential parts: 46 lbs
2. Leading Edge Dimensions
   - a. Nose plate anchor hole to:
     - 1. Crossbar attachment hole 123.0
     - 2. Rear sail attachment point 209.0 - 209.25
   - b. Outside diameter at:
     - 1. Nose 2.05
     - 2. Crossbar 2.05
   - c. Rear sail attachment point 1.97
3. Crossbar Dimensions
   - a. Overall pin to pin length from leading edge attachment point to hinge bolt at glider centerline 97.75
   - b. Largest outside diameter 2.05
4. Keel dimensions; least and greatest allowable distances, whether variable through tuning or through in-flight variable geometry, from the line joining the leading edge nose bolts to:
   - a. The xbar center load bearing pin 61.5
   - b. The pilot hang loop 71.5 - 75.5
5. Sail Dimensions
   - a. Chord lengths at:
     - 1. 3 ft outboard of centerline 100.2
     - 2. 3 ft inboard of tip 54.7
   - b. Span (extreme tip to tip) 338
6. Location of Information Placard Keel

   Location of Test Fly Sticker Keel
7. Recommended Pilot Weight Range 125 - 200
8. Recommended Pilot Proficiency USHGA Novice

HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL Alpha 210

MANUFACTURED BY Wills Wing Inc.

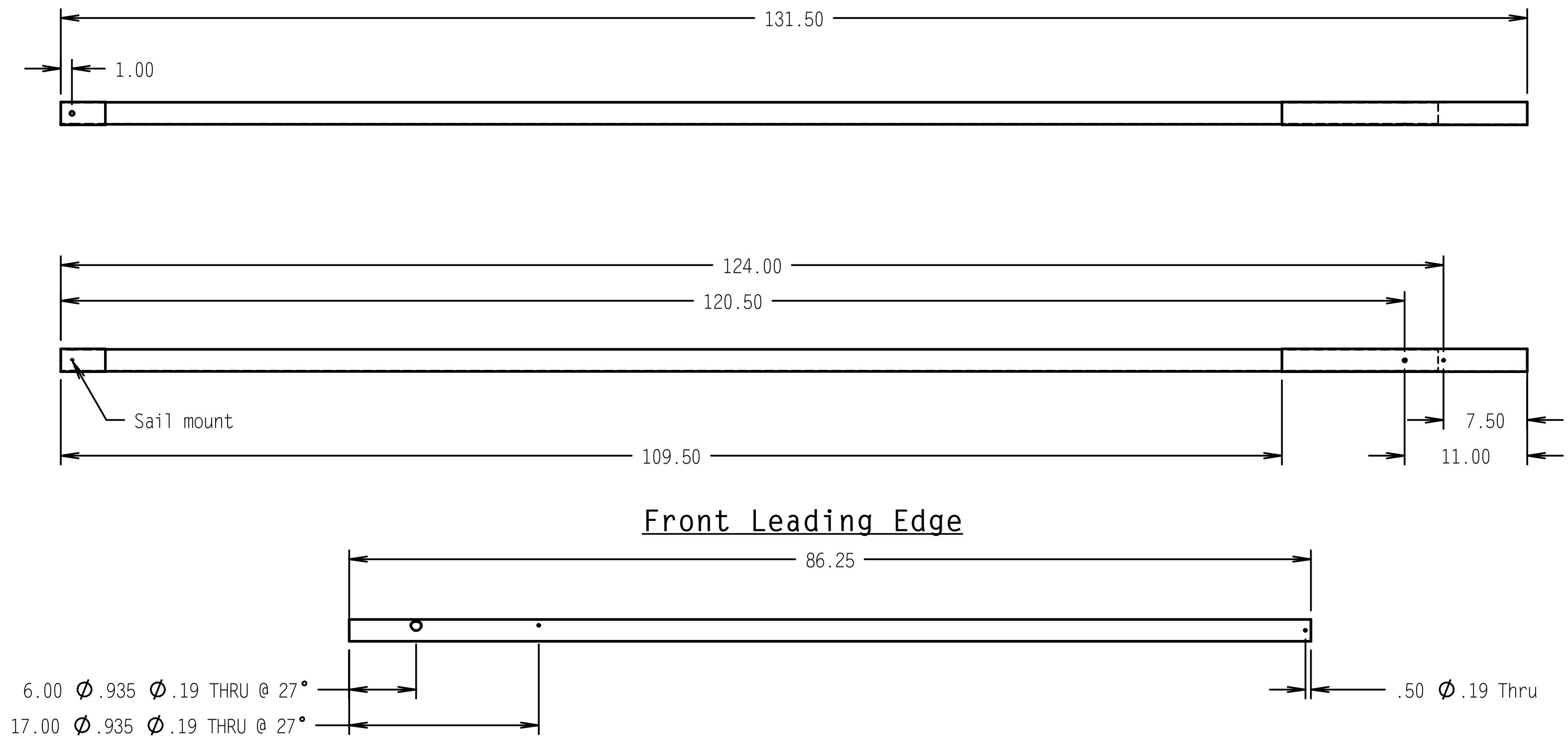
All dimensions in inches; weights in pounds.

NOTE: These specifications are intended only as a guideline for determining whether a given glider is a certified model and whether it is in the certified configuration.

Be aware, however, that no set of specifications, however detailed, can guarantee the ability to determine whether a glider is the same model, or is in the same configuration as was certified, or has those performance, stability, and structural characteristics required by the certification standards. An owner's manual is required to be delivered with each HGMA certified glider, and it is required that it contain additional airworthiness information.

1. Weight of glider with all essential parts and without coverbags and nonessential parts: 51 lbs
2. Leading Edge Dimensions
   a. Nose plate anchor hole to:
      1. Crossbar attachment hole 127.0
      2. Rear sail attachment point 222.5 - 222.75
   b. Outside diameter at:
      1. Nose 2.05
      2. Crossbar 2.05
      3. Rear sail attachment point 1.97
3. Crossbar Dimensions
   a. Overall pin to pin length from leading edge attachment point to hinge bolt at glider centerline 106.75
   b. Largest outside diameter 2.05
4. Keel dimensions; least and greatest allowable distances, whether variable through tuning or through in-flight variable geometry, from the line joining the leading edge nose bolts to:
   a. The xbar center ball center 61.5
   b. The pilot hang loop 74.25 - 78.25
5. Sail Dimensions
   a. Chord lengths at:
      1. 3 ft outboard of centerline 106.0
      2. 3 ft inboard of tip 53.5
   b. Span (extreme tip to tip) 370.5
6. Location of Information Placard Keel
   Location of Test Fly Sticker Keel
7. Recommended Pilot Weight Range 150 - 280
8. Recommended Pilot Proficiency USHGA Novice

Item	Part Name	Length	Length mm	Material	Weight	QTY.
1	Alpha 180 Front LE	123.500	3137	50mm x 0.9mm 7075-T6	0.96	1
2	Alpha Front LE slv3	123.500	3137	50mm x 0.9mm 7075-T6	0.96	1
3	Alpha 180 Front LE middle slv	123.500	3137	50mm x 0.9mm 7075-T6	0.96	1
4	Alpha Rear LE Left	123.500	3137	50mm x 0.9mm 7075-T6	0.96	1



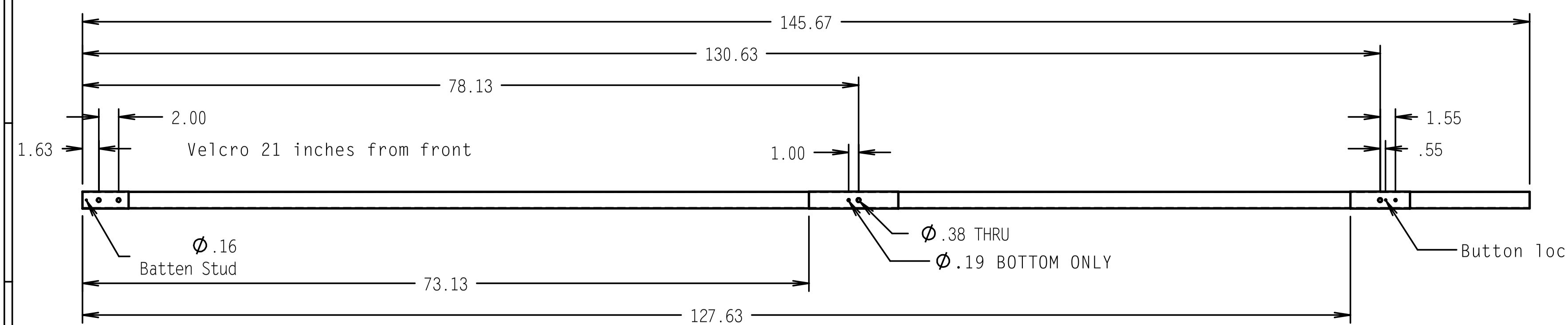
Left Rear Leading Edge

Revisions		
REV.	DESCRIPTION	DATE
C	Alpha Rear Leading Edge Slot to Hole	6/1/2015

WILLS WING
500 BLUERIDGE AVE • ORANGE, CA 92865 • PH/FAX (714) 998-6359 / 998-0647

TITLE: Alpha 180 Leading Edge					REVISION: C
SLDDWF ID: Alpha 180 Airframe	DOCUMENT ID: NA	DRAWN: 1/30/2007	REVISED: 6/1/2015	STATUS: -	BY: PEARSON

Item	Part Name	Length	Length mm	Material	Weight	Qty
1	Alpha Keel front slv	4.63	118	44mm x 0.9mm 7075-T6	0.03	1
2	Alpha Keel middle slv	9.00	229	44mm x 0.9mm 7075-T6	0.06	1
3	Alpha Keel rear slv	6.00	152	44mm x 0.9mm 7075-T6	0.04	1
4	Alpha 180 Keel	145.67	3700	42mm x 0.9mm 7075-T6	0.00	1



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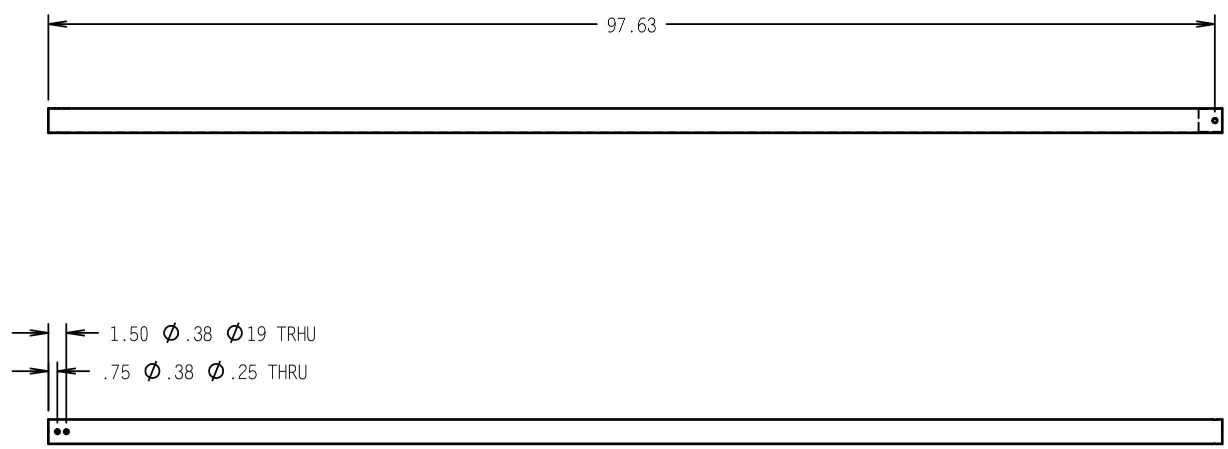
TITLE: Alpha 180 Keel

REVISION: B

SLDDWF ID:	DOCUMENT ID:	DRAWN:	REVISED:	STATUS:	BY:
Alpha 180 Airframe	NA	1/30/2007	2/27/2014	-	PEARSON

Item	Part Name	Length	Length mm	Material	Weight	Qty
1	Alpha 180 Xbar	98.25	2496	52mm x 0.9mm 7075-T6	0.78	1
2	Alpha 180 Xbar Outboard slv 50	2.00	51	50mm x 0.9mm 7075-T6	0.02	1



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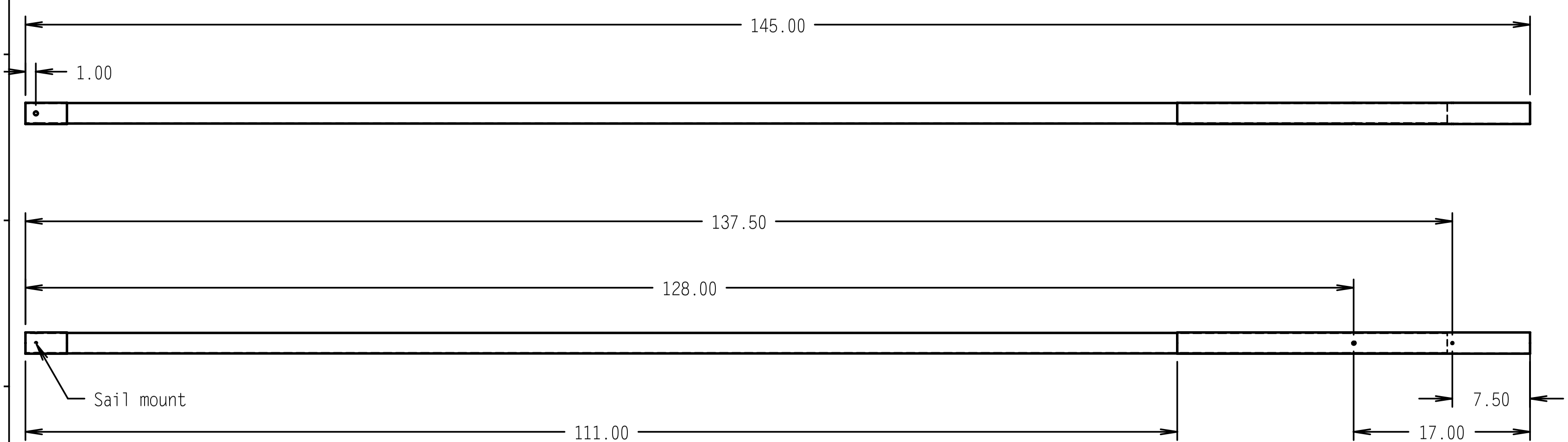
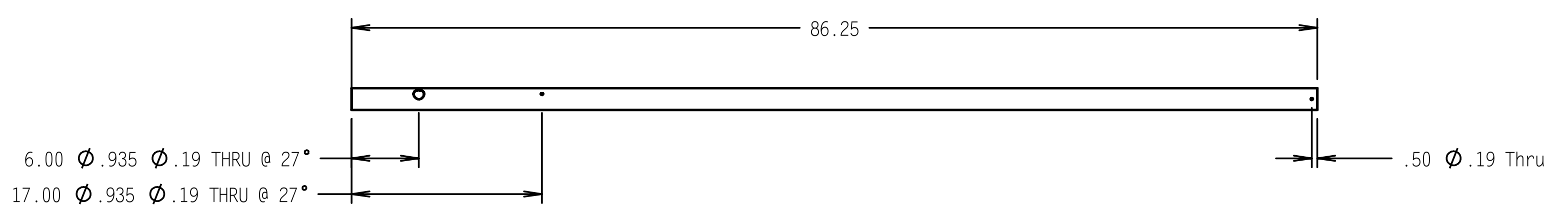
TITLE: Alpha 180 Xbar						REVISION: B
SLDDWF ID: Alpha 180 Airframe	DOCUMENT ID: NA	DRAWN: 1/30/2007	REVISED: 2/27/2014	STATUS: -	BY: PEARSON	

Item	Part Name	Length	Length mm	Material	Weight	QTY.
1	Alpha 210 Front LE	123.500	3137	50mm x 0.9mm 7075-T6	0.96	1
2	Alpha Front LE slv3	123.500	3137	50mm x 0.9mm 7075-T6	0.96	1
3	Alpha 210 Front LE middle slv	123.500	3137	50mm x 0.9mm 7075-T6	0.96	1
4	Alpha Rear LE Left	123.500	3137	50mm x 0.9mm 7075-T6	0.96	1



Front Leading Edge



Left Rear Leading Edge

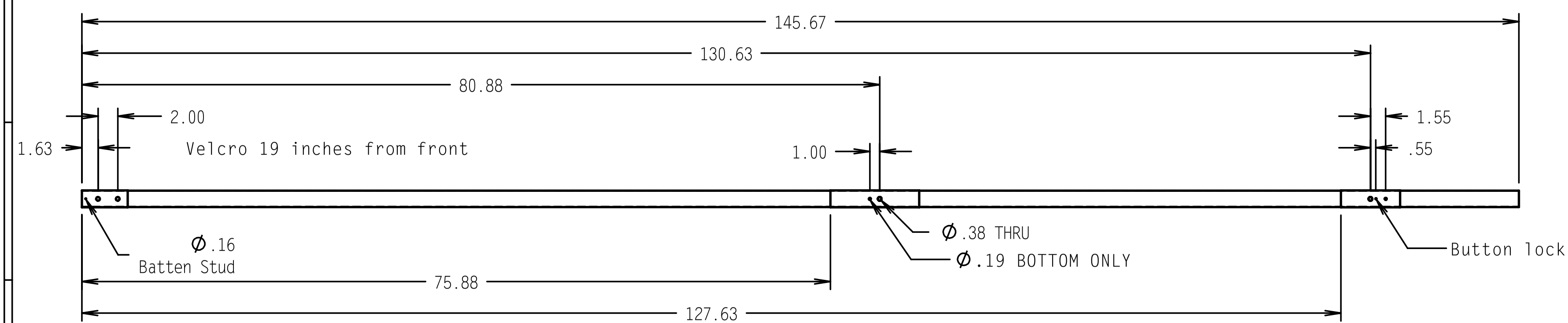
Revisions		
REV.	DESCRIPTION	DATE
C	Rear Leading Edge Slot to Hole	6/1/2015

WILLS WING

500 BLUERIDGE AVE ● ORANGE, CA 92865 ● PH/FAX (714) 998-6359 / 998-0647

TITLE: Alpha 210 Leading Edge						REVISION: B
SLDDWF ID: Alpha 210 Airframe	DOCUMENT ID: NA	DRAWN: 1/30/2007	REVISED: 2/27/2014	STATUS: -	BY: PEARSON	

Item	Part Name	Length	Length mm	Material	Weight	Qty
1	Alpha 210 Keel	145.67	3700	42mm x 0.9mm 7075-T6	0.95	1
2	Alpha Keel front slv	4.63	118	44mm x 0.9mm 7075-T6	0.03	1
3	Alpha Keel middle slv	9.00	229	44mm x 0.9mm 7075-T6	0.06	1
4	Alpha Keel rear slv	6.00	152	44mm x 0.9mm 7075-T6	0.04	1



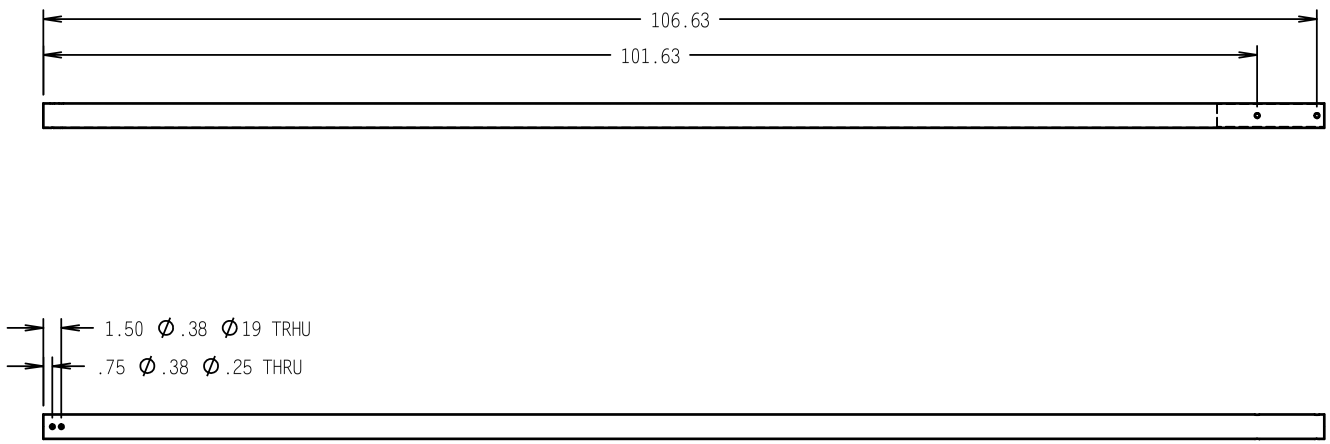
WILLS WING
500 BLUERIDGE AVE • ORANGE, CA 92865 • PH/FAX (714) 998-6359 / 998-0647

TITLE: **Alpha 210 Keel**

REVISION: B

SLDDWF ID:	DOCUMENT ID:	DRAWN:	REVISED:	STATUS:	BY:
Alpha 210 Airframe	NA	1/30/2007	2/27/2014	-	PEARSON

Item	Part Name	Length	Length mm	Material	Weight	Qty
1	Alpha 210 Xbar	107.25	2724	52mm x 0.9mm 7075-T6	0.86	1
2	Alpha Xbar Outboard slv 50	9.00	229	50mm x 0.9mm 7075-T6	0.07	1

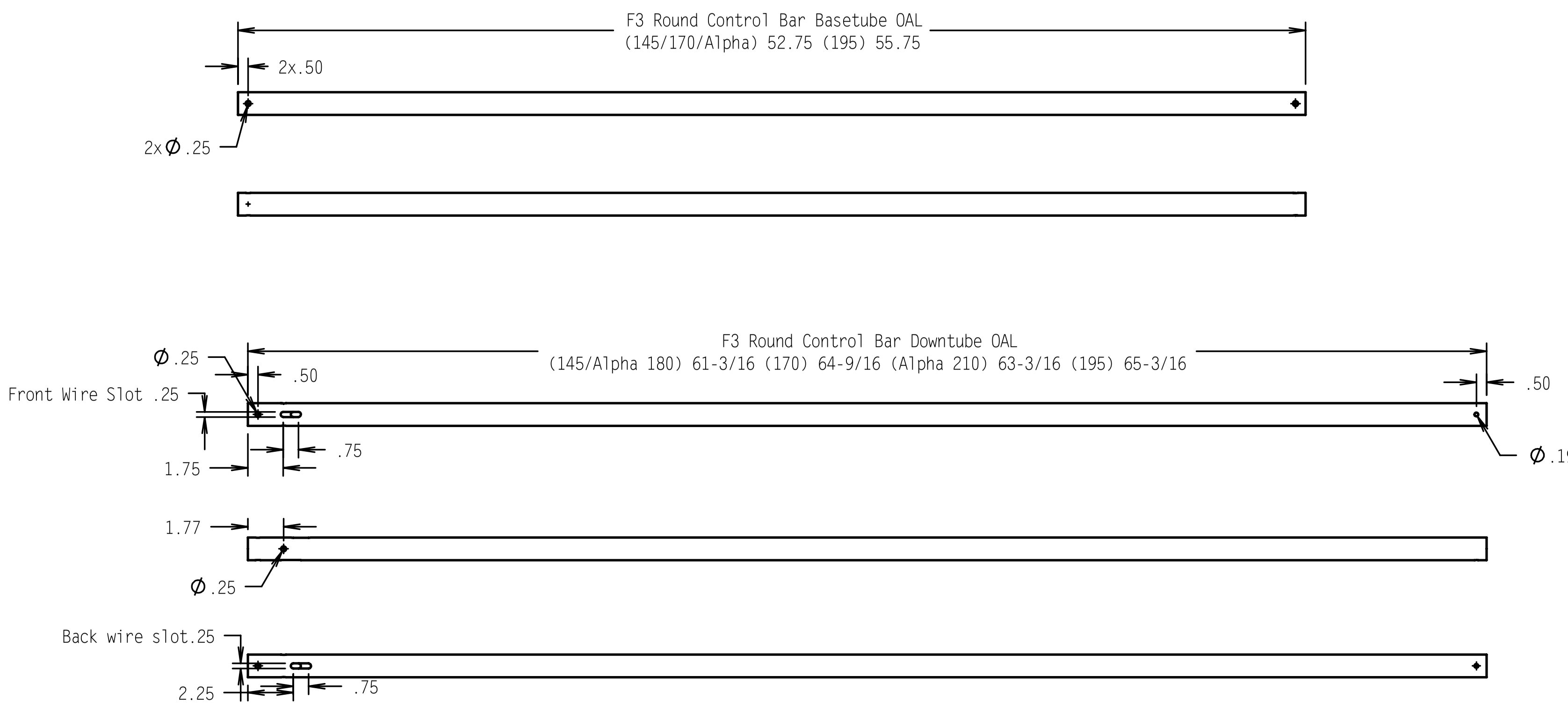


WILLS WING
500 BLUERIDGE AVE ● ORANGE, CA 92865 ● PH/FAX (714) 998-6359 / 998-0647

TITLE: Alpha 210 Xbar					REVISION: B
SLDDWF ID: Alpha 210 Airframe	DOCUMENT ID: NA	DRAWN: 1/30/2007	REVISED: 2/27/2014	STATUS: -	BY: PEARSON

Falcon 3, Falcon 4 and Alpha Control Bar Application Table.

Model	Round Control Bar Part No			Litestream Control Bar Part No			Litestream OAL		Round control bar Specifications			
	Downtube	Speedbar	Straight Base	Litesteam DT	LS-Round Base	Streamline Base	Downtube	Basetube	Round Downtube Material Spec	Round DT OAL	Round BT OAL	Downtube Innersleeve Spec
F3 145	40G-1215	40F-1329	40F-1328	40G-1478	40F-1365	40F-1521	60.0	49.5	1.125 x .065 6061-T6	61.188	52.75	none
F3 170	40G-1225	40F-1329	40F-1328	40G-1477	40F-1365	40F-1521	62.0	49.5	1.125 x .065 6061-T6	63.188	52.75	none
F3 195	40G-1236	40F-1339	40F-1338	40G-1471	40F-1367	40F-1511	65.0	52.5	1.125 x .065 6061-T6	66.188	55.75	40.0 x 0.985 x .035 6061-T6
Alpha 180	40G-1215	40F-1329*	40F-1328	NA	NA	NA	NA	NA	1.125 x .065 6061-T6	61.188	52.75	none
Alpha 210	40G-1235	40F-1239*	40F-1328	NA	NA	NA	NA	NA	1.125 x .065 6061-T6	64.688	52.75	none



WILLS WING

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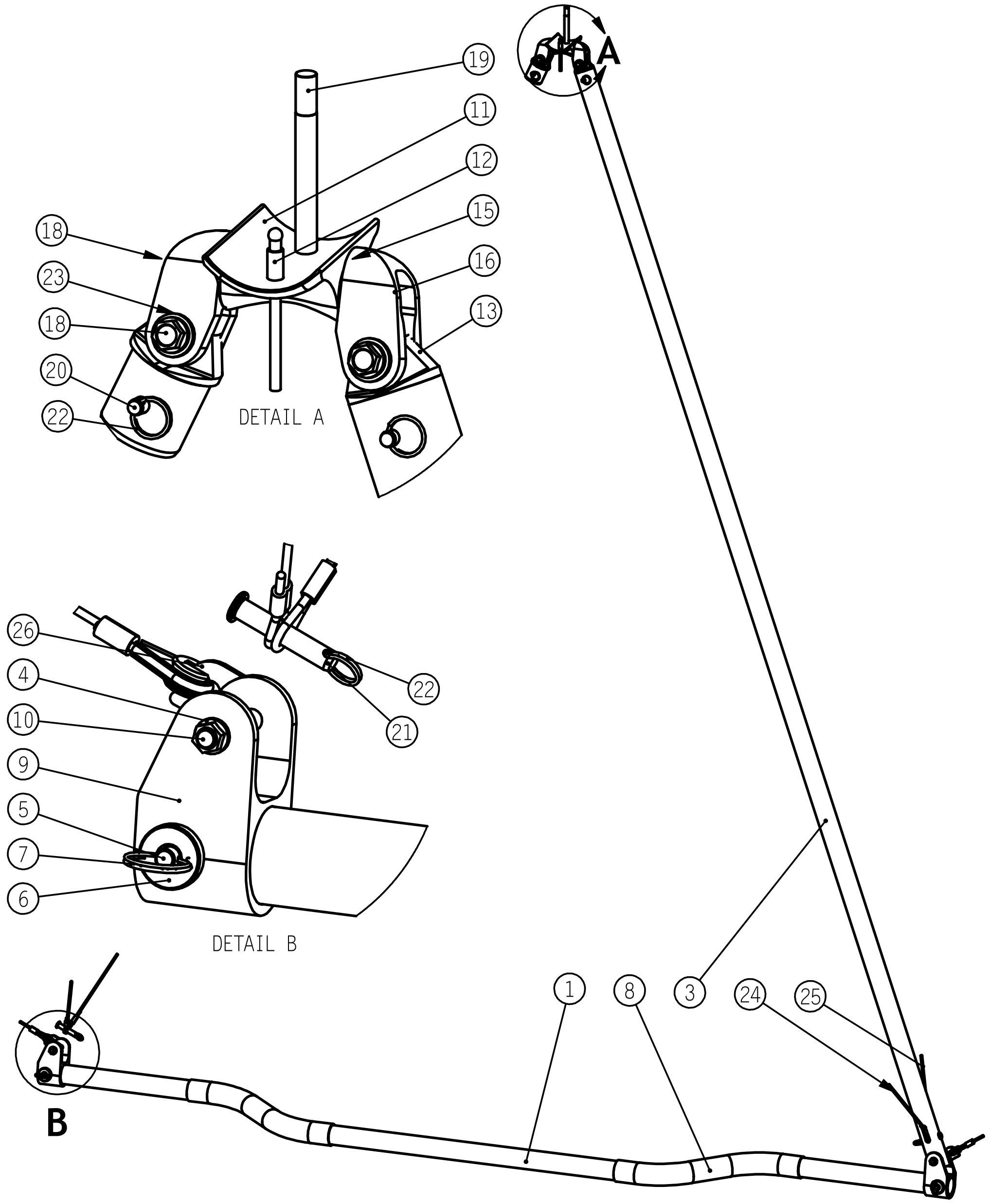
TITLE: Falcon 3/4 and Alpha Downtube and Basetube						REVISION: C
SLDDWF ID: Falcon 3 Downtubes	DOCUMENT ID: Falcon 3 Downtubes	DRAWN: 1/1/2005	REVISED: 6/1/2015	STATUS:	BY: PEARSON	

ID	Part No	Part Name	QTY.
1	40F-13nn	BASE TUBE F3 SPEEDBAR (SEE TABLE)	1
2	40F-13nn	BASE TUBE F3 STRAIGHT (SEE TABLE)	
3	40G-12nn	LEG F3 6X ROUND (SEE TABLE FOR SIZES)	2
4	10N-1740	CLINCH NUT 1/4 MS21042-4	4
5	10A-2160	AN4-16	2
6	10N-1445	SPEEDNUT 1/4 X 28	2
7	10P-1200	SAFETY RING AN R2 LARGE	2
8	15A-1401	GRIP BASETUBE POLYFOAM	2
9	20G-1814	CBAR BASE BRK FALCON 3	2
10	10A-2161	AN4-16A	2
11	20G-1617	BRACKET KEEL CNTR 44MM SHORT	1
12	10R-0363	RIVET AL 3/16 X .25 CCPQ-64 SS Q	1
13	20G-1414	CBAR PLUG F4 LEG TOP ROUND	2
14	20G-1714	CBAR ELBOW	2
15	10U-5125	WASHER NYLON .75 X .316 X .020	2
16	10A-3231	AN5-23A	1
17	10N-1030	LOCKNUT 5/16 AN365-5	1
18	10C-5111	NAS623-4-11	2
19	10C-2291	NAS517-4-29	1
20	10G-1370	MS20392-2C37	2
21	10G-2370	MS20392-3C37	2
22	10P-1100	SAFETY RING AN 9491 SMALL	4
23	10U-1140	WASHER STEEL AN960-416 1/4 THICK	2
24	40P-3302	WIRE SET BOTTOM REAR SLIPSTREAM	2
25	40P-3203	WIRE SET BOTTOM FRONT SLIPSTREAM	2
26	40P-3105	WIRE BOTTOM SIDE SLIPSTREAM	2

	Leg F3	Base F3 Straight	Base F3 Speedbar
Alpha 180	40G-1215	40F-1328	40F-1329
Alpha 210	40G-1235	40F-1328	40F-1329
Falcon 4 145	40G-1215	40F-1328	40F-1329
Falcon 4 170	40G-1225	40F-1328	40F-1329
Falcon 4 195	40G-1236	40F-1338	40F-1339



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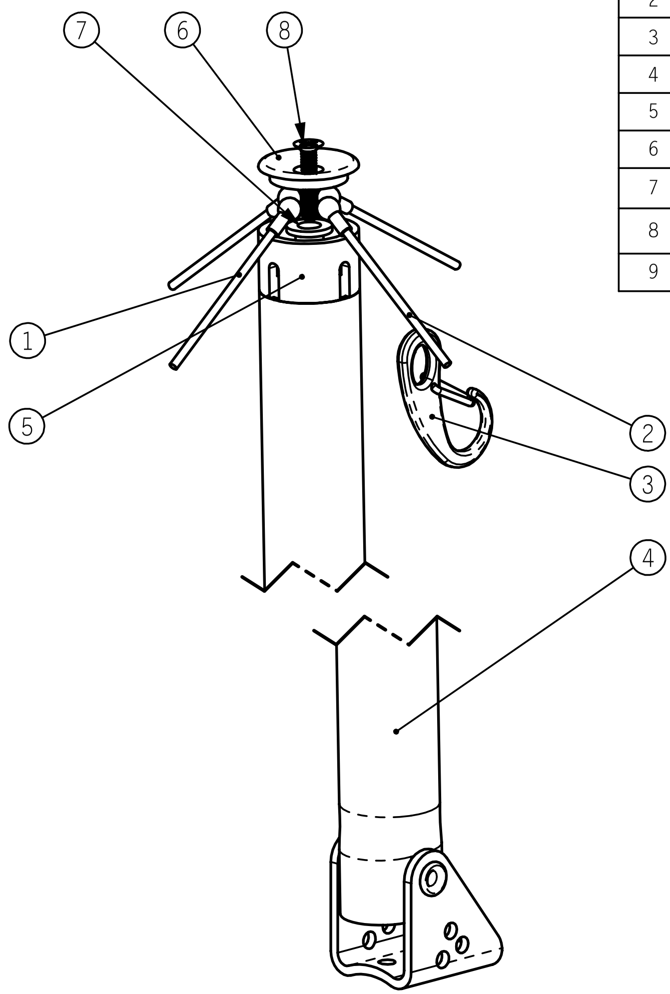
TITLE:					REVISION:
Falcon 3, Falcon 4 and Alpha Round Control Bar					F
SLDDWF ID: F3 Control Bar Round	DOCUMENT ID:	DRAWN: 5/1/2008	REVISED: 6/1/2015	STATUS:	BY: PEARSON



BOM Table			
ID	Part No	Part Name	Qnt
1	40P-2301	WIRE TOP FRONT BALL SWG 3/32	1
2	40P-2202	WIRE TOP SIDE BALL SWG 3/32	2
3	40P-2402	WIRE TOP REAR BALL W/PIGTAIL	1
4	10K-1006	KINGPOST ROUND W/BRACKET ALPHA/CONDOR	1
5	20G-2325	Kingpost Top Ball Cable 3-32 Alpha	1
6	20G-2326	Kingpost Cap Ball Cable 3-32 Alpha	1
7	10T-5108	Spacer Nylon Shoulder with Flange .31 x .75	1
8	10M-1101	100 Degree Flat Head Phillips Machine Screw #8-32 x .875	1
9	45G-3055	Sock Elastic KP Base Condor/Alpha	1

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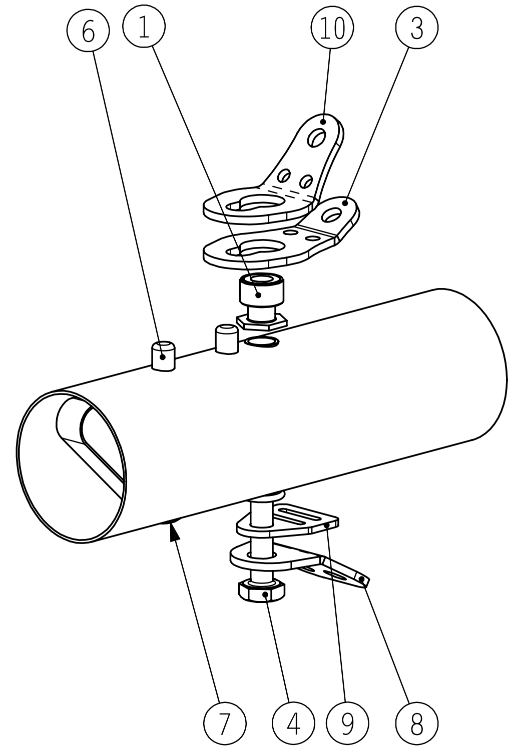
TITLE: Alpha Kingpost Assembly					REVISION: A
SLDDWF ID: Falcon 3 Kingpost Assy	DOCUMENT ID:	DRAWN: 6/1/2015	REVISED: 6/1/2015	STATUS:	BY: PEARSON

ITEM	Part No	Description	Qty
1	20G-2904	Collar Keyhole Low-Pro Rear2	1
2	10N-1740	CLINCH NUT 1/4 MS21042-4	1
3	40P-4204	WIRE XBAR SWEEP CNFTR HINGE SET	1
4	10A-2241	AN4-24A	1
5	10T-1161	BUSH 3011-T3 .375 * .035	1
6	20A-1511	BUTTON SPRING HAULBACK LOCK	1
7	10R-0364	RIVET AL 3/16 X .375 CHAAPQ6-2	1
8	40P-3302	WIRE SET BTM REAR SLPSTR-LTSTR	1
9	20E-2321	TANG 1 HOLE 2 SLOT 5/8 WEBBING	1
10	40P-2402	WIRE TOP REAR BALL W/PIGTAIL	1



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TITLE: Alpha Rear Keel

REVISION: A

SLDDWF ID: U2 Rear Keel

DOCUMENT ID:

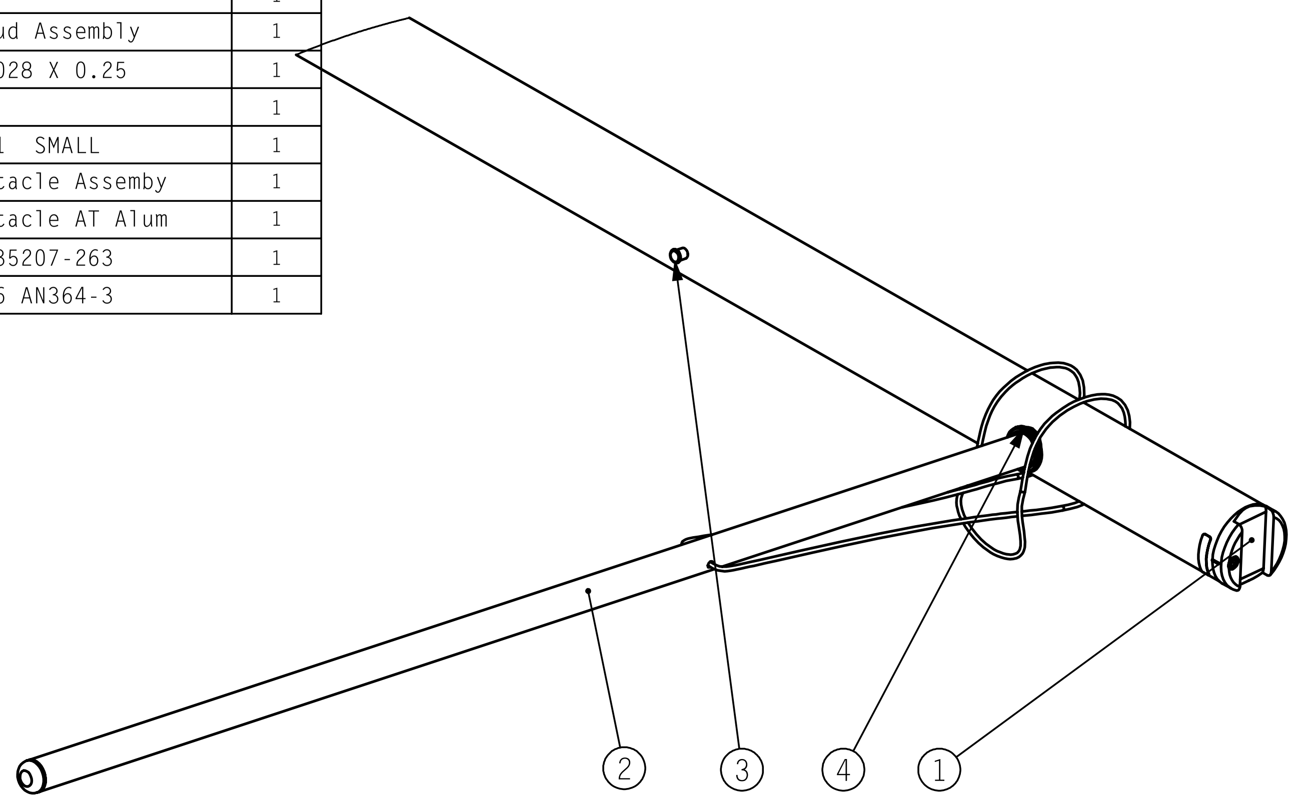
DRAWN: 6/1/2015

REVISED: 6/1/2015

STATUS:

BY: PEARSON

ID	Part No	Part Name	Qnt
1	NA	Sail Adjuster Assembly	1
	15J-1911	ENDCAP SAIL MOUNT ADJUSTABLE	1
	15J-1912	LOCKING SLIDE ADJUST ENDCAP	1
	10K-2026	SCREW SOCKET CAP 10-32X1.75 SS	1
	10U-1130	WASHER STEEL AN960-10	1
	10S-1101	C-CLIP SAIL ADJUSTER CAP SCREW	1
	70G-4019	PLACARD - SAIL ADJUSTER ALIGN	1
2	NA	Washout Tube Assembly	1
	40M-1144	WASHOUT TUBE BUNGEE RETAIN	1
	15B-0608	ENDCAP 3/4 MULTIGAUGE	1
	30J-3101	BUNGEE - 1/8	1
3	NA	Number 1 Batten Stud Assembly	1
	10T-1108	SPACER AL .250 X .028 X 0.25	1
	10G-1710	MS20392-2C71	1
	10P-1100	SAFETY RING AN 9491 SMALL	1
4	NA	Washout Tube Receptacle Assemby	1
	20G-2411	Washout Tube Receptacle AT Alum	1
	10L-1061	SCREW PAN 3/16 MS35207-263	1
	10N-1130	LOCKNUT LOWPRO 3/16 AN364-3	1



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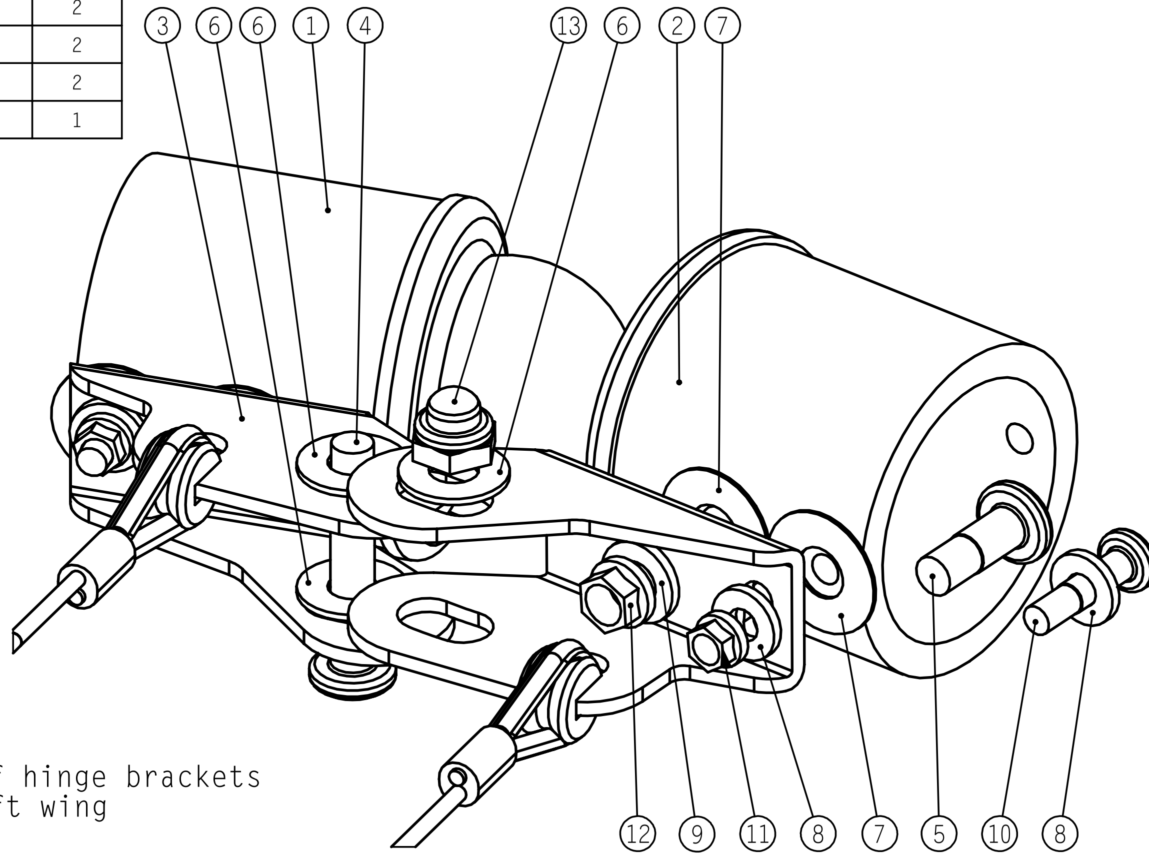
TITLE:	REVISION:
Alpha Rear Leading Edge	A

SLDDWF ID:	DOCUMENT ID:	DRAWN:	REVISED:	STATUS:	BY:
Alpha Xbar LE		6/1/2015	6/1/2015		PEARSON

ID	Part No	Part Name	Qnt
1	15J-2123	BALL XBAR CNTR BALL JNT 52	1
2	15J-2113	SOCKET XBAR CNTR BALL JNT 52	1
3	40P-4204	WIRE XBAR SWEEP CNTR HINGE SET	1
4	10C-5181	NAS623-4-18	1
5	10C-5061	NAS623-4-6	2
6	10U-4100	WASHER BRASS .625X .281X .04	4
7	10U-5125	WASHER NYLON .75 X .316 X .020	4
8	10U-1130	WASHER STEEL AN960-10	4
9	10U-1140	WASHER STEEL AN960-416 1/4 THICK	2
10	10C-4081	NAS623-3-8	2
11	10N-1730	CLINCH NUT 3/16 MS20142-3	2
12	10N-1740	CLINCH NUT 1/4 MS21042-4	2
13	10N-0040	LOCKNUT LOW PRO 52NKTE-048	1



Note orientation of hinge brackets
Right wing over left wing

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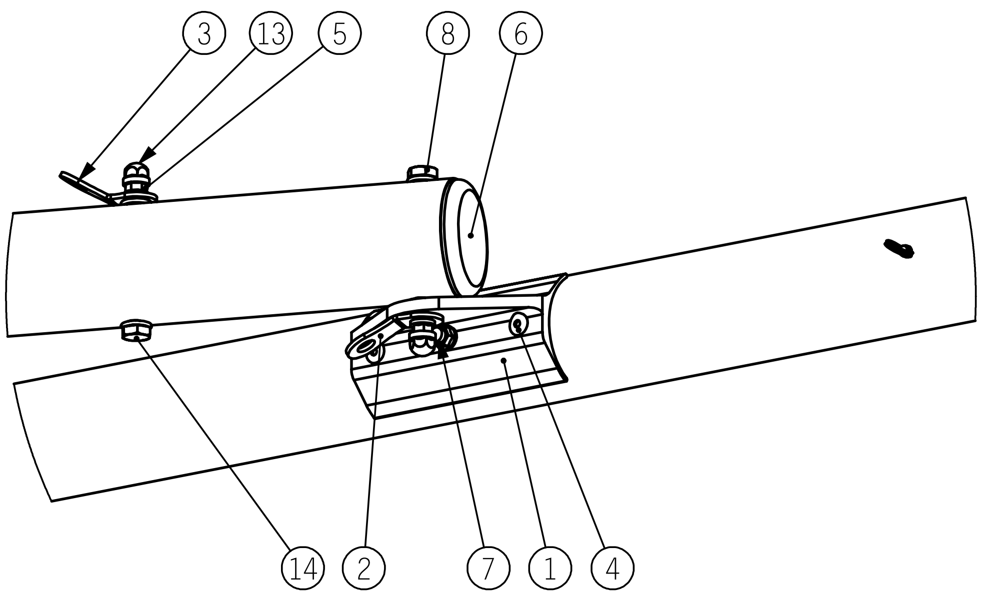
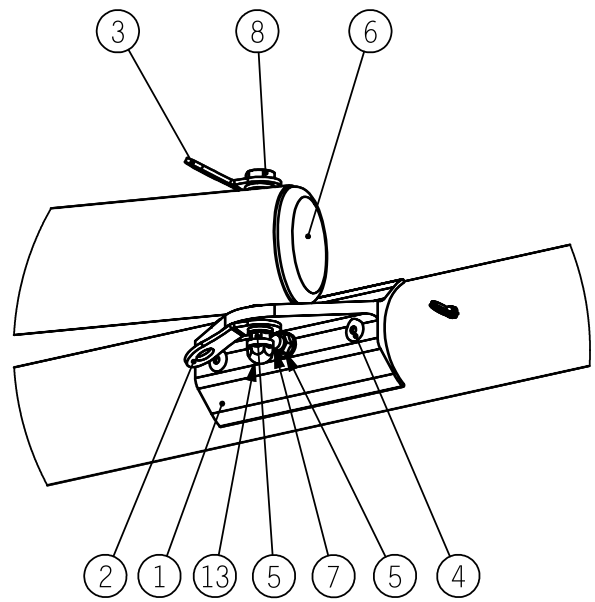
TITLE: Alpha Xbar Center					REVISION: A
SLDDWF ID: Falcon 3 Ball Center	DOCUMENT ID:	DRAWN: 6/1/2015	REVISED: 6/1/2015	STATUS:	BY: PEARSON

ID	Part No	Part Name	Qnt
1	20G-1110	XBAR/LE BRACKET 52MM LDNG EDGE	1
2	40P-3103	WIRE BOTTOM SIDE 3/32 AT STYLE	1
3	40P-2202	WIRE TOP SIDE BALL SWG 3/32	1
4	10R-0366	RIVET AL 3/16 X .375 CHAAPQ6-4	2
5	10N-1740	CLINCH NUT 1/4 MS21042-4	3
6	15B-2013	ENDCAP 2.0 IN MULTIGAUGE	1
7	10K-2031	SCREW SOCKET CAP SS 1/4x28x5/8	1
8	10A-2271	AN4-27A	1
9	10G-1650	MS20392-2C65	1
10	10P-1100	SAFETY RING AN 9491 SMALL	2
11	10T-1108	SPACER AL .250 X .028 X 0.25	1
12	10G-1710	MS20392-2C71	1
13	15A-2010	Threaded Nutcap	2
14	10A-2251	AN4-25A	1

ID	Part No	Part Name	Qnt
1	20G-1110	XBAR/LE BRACKET 52MM LDNG EDGE	1
2	40P-3103	WIRE BOTTOM SIDE 3/32 AT STYLE	1
3	40P-2202	WIRE TOP SIDE BALL SWG 3/32	1
4	10R-0366	RIVET AL 3/16 X .375 CHAAPQ6-4	2
5	10N-1740	CLINCH NUT 1/4 MS21042-4	2
6	15B-2013	ENDCAP 2.0 IN MULTIGAUGE	1
7	10K-2031	SCREW SOCKET CAP SS 1/4x28x5/8	1
8	10A-2271	AN4-27A	1
9	10G-1650	MS20392-2C65	1
10	10P-1100	SAFETY RING AN 9491 SMALL	2
11	10T-1108	SPACER AL .250 X .028 X 0.25	1
12	10G-1710	MS20392-2C71	1
13	15A-2010	Threaded Nutcap	1



Alpha 210



Alpha 180

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TITLE: Alpha Xbar LE Junction					REVISION: A
SLDDWF ID: Alpha Xbar LE	DOCUMENT ID:	DRAWN: 6/1/2015	REVISED: 6/1/2015	STATUS:	BY: PEARSON