WILLS WING



Ultra Sport 135,147,166

Owner / Service Manual

July 1998 - Third Edition

Ultra Sport 135,147,166

Owner / Service Manual

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Contents

Introduction 1
Disclaimer and Warning 2
Technical Information and Placarded Operating Limitations 3
Ultra Sport Breakdown Procedure for Shipping and Reassembly Procedure 6
Ultra Sport Set-Up Procedure 7
Preflight Procedure 12
Laying the Glider Down Flat 15
Setting the Glider Up Flat on the Ground 15
Launching and Flying the Ultra Sport 16
Trimming Your Glider in Pitch 19
Speeds to Fly and Using a Hall Airspeed Indicator 20
Using the VG System 21
Flying Fast Without Oscillations 21
Landing the Ultra Sport 23
Ultra Sport Breakdown 25
Ultra Sport Stability Systems 26
Ultra Sport Reflex Bridle Adjustment and Flight Testing 26
Maintenance 29
Removing the Sail from the Airframe and Re-Installing 31
Glider Tuning 33
Car Top Mounting and Transport 36
In Closing 36
Ultra Sport 135, 147, 166 Assembly Diagrams—Table of Contents **A-1**

Ultra Sport 147 Middle/Rear Keel A-2
Ultra Sport 147 VG Assembly A-3
Ultra Sport 147 Crossbar Assembly A-4
Ultra Sport 147 Noseplate Assembly A-5
Ultra Sport 147 Kingpost Assembly A-6
Ultra Sport 135 and 166 Rear Keel A-7
Ultra Sport 135 and 166 Middle Keel A-8
Ultra Sport 135 and 166 Cam VG A-9
Ultra Sport 135 and 166 Crossbar Center A-10
Ultra Sport 135 and 166 Noseplate A-11
Ultra Sport 135 and 166 Kingpost A-12
VG Control Bar Assembly A-13
VG Folding Basetube Assembly A-14
Ultra Sport Rear Leading Edge Assembly A-15
Ultra Sport Control Bar Specifications A-16
Ultra Sport 147 Airframe A-17
Ultra Sport 166 Airframe A-18
Ultra Sport 135 Airframe A-19
Control Bar Apex Button Lock A-20

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.

If you have access to the Internet, please visit us at http://www.willswing.com. The site features extensive information about Wills Wing gliders and products, a Wills Wing Dealer directory, our complete retail price list, a site search engine, and more.

The most important contents of our internet site are the service and technical bulletins, and the latest editions of owners manuals. This is your single best source for safety and airworthiness advisories on Wills Wing products. Many of the documents are published in Adobe Acrobat format. A free viewer for Acrobat files is available at http://www.adobe.com.

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

Rob Kells, 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. Federal Aviation Regulation Part 103 states in part, "ultralight vehicles are not required meet the airworthiness certification standards specified for aircraft or to have certificates of airworthiness" and "operators of ultralight vehicles are not required to meet any aeronautical knowledge, age, or experience requirements to operate those vehicles or to have airman or medical certificates." Wills Wing hang gliding products are not covered by product liability insurance. As a hang glider pilot, you are entirely responsible for your own safety. You should never attempt to fly a hang glider without having received competent instruction. We strongly recommend that you not participate in hang gliding unless you recognize fully and wish to personally assume all of the associated risks.

Please fly safely.

Wills Wing, Inc.

Technical Information and Placarded Operating Limitations

The Ultra Sport 135, 147 and 166 have been tested and found to comply with the Hang Glider Manufacturers Association (HGMA) Airworthiness Standards. These 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 speed for the Ultra Sport for this test was 65 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 speed for the Ultra Sport for this test was 46 m.p.h..

3. A negative 150 degree angle of attack load test at a speed equal to at least the greater of 30 m.p.h. or 50% of the required positive load test speed for at least 3 seconds without failure.

    The required speed for the Ultra Sport for this test was 32 m.p.h..

4. For the Ultra Sport with a Vne of 53 m.p.h., pitch tests at speeds of 20 m.p.h., 37 m.p.h. and 53 m.p.h. which show the glider to be stable 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 37 m.p.h., and from 10 degrees above zero lift angle to zero lift angle at 53 m.p.h..

5. Flight maneuvers which show the glider to be adequately stable and controllable throughout the normal range of operation.

NOTE: The Ultra Sport has been designed for foot launched soaring flight. It has not been designed to be motorized, tethered, or towed. It can be towed successfully using proper 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 Ultra Sport 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 Ultra Sport is generally resistant to spinning, but may spin from a stalled turn, especially if the VG is adjusted at or near the tight end of the range, and the rate of application of pitch is moderately rapid. The Ultra Sport can be induced to spin at any VG setting. Recovery from a spin requires unstalling of the wing, and it is therefore critically important that in the event of a spin, no application of nose up pitch control be held. The Ultra Sport 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. The Ultra Sport provides the pilot with a high degree of pitch authority, in combination with a very low twist sail. As a result, it is possible by pushing fully out on the bar to produce a very aggravated and severe stall, the recovery from which may involve very severe pitch down rotation, the pilot going weightless, and the glider recovering via an unpredictable trajectory with a significant altitude loss. Therefore, full arms extension aggravated stalls should not be induced except on landing flare.

The maximum steady state speed for a prone pilot in the middle of the recommended weight range full forward on the control bar with the VG set full tight is approximately 53 m.p.h. for the Ultra Sport 147 and 50 m.p.h. for the Ultra Sport 135 and 166. The placarded speed never to exceed for the Ultra Sport is 53 m.p.h.. An optional airspeed indicator is available for the Ultra Sport and can be used by the pilot as an aid to comply with the placarded limitations.

The placarded maximum maneuvering speed, and the placarded maximum rough air speed of the Ultra Sport are each 46 m.p.h.. This speed will be achieved with the control bar basetube approximately six inches below the waist. This speed should not be exceeded in anything other than smooth air. No abrupt maneuvering or control inputs should be made at anything above this speed.

The stability, controllability, and structural strength of a properly maintained Ultra Sport 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 Ultra Sport at maximum recommended wing loading is 25 m.p.h. 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 42 m.p.h.. All speeds given above are indicated airspeeds, for a properly calibrated airspeed indicator mounted in the vicinity of the pilot. Wills Wing sells such an airspeed indicator as an accessory. It is recommended that the pilot fly with such an airspeed indicator. Refer to the section on using the airspeed indicator for further information on speeds to fly.

The recommended hook in pilot weight range for the Ultra Sport is:

Ultra Sport 135: 125 - 210 lbs.
Ultra Sport 147: 150 - 250 lbs.
Ultra Sport 166: 175 - 285 lbs.

Be advised that pilots with hook in weights of less than 20 lbs above minimum will find the Ultra Sport more demanding of pilot skill to fly, and that pilots hooking in within 20 lbs of the maximum will experience some relative degradation of optimum sink rate performance due to their higher wing loading.

A minimum USHGA Intermediate (III) level of pilot proficiency is required to fly the Ultra Sport safely. Pilots are advised that the optimum proficiency level for the Ultra Sport is higher than the minimum recommended. Operation of the glider by unqualified or under qualified pilots may be dangerous.

Operating the Ultra Sport outside of the above limitations may result in injury and death. Flying the Ultra Sport 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 do know that 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.

Ultra Sport Breakdown Procedure for Shipping and Reassembly Procedure

The front leading edge is 50mm (1.97") oversleeved with 52mm (2.05") at the crossbar junction. The rear leading edge is 50mm and slotted at the forward end and engages in a clevis in the 52mm oversleeve.

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 mount webbing from the slotted endcap. You may find it helpful to use a large, flat bladed screw driver to pry the webbing out of the slot and over the endcap. Take care not to 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). Push the sail up to where you have uncovered the point where the rear leading edge exits the front. Trace around the circumference of the 50 mm rear leading edge just along the aft edge of the 52mm oversleeve so as to mark the point at which the rear leading edge is fully engaged in the front.
3. Scribe a line along the leading edge which crosses the rear leading edge to 52mm oversleeve junction. This will help to align the rear leading edge during reassembly.
4. Pull the rear leading edge straight aft to disengage it from the front. Put tape or padding on the sharp edges of the front end of the rear leading edge tubes.
5. Carefully fold the rear of the sail over against the front, and replace the bag on the glider.

Remounting the rear leading edges

1. Make sure you are mounting the correct leading edge rear into the correct front (check the "right" / "left" designation).
2. Spray the forward six inches of the rear leading edge with silicone spray lubricant.
3. Slide the rear leading edge into the front, lining up the rotational alignment marks you made during breakdown, until the rear engages fully in the front leading edge, as indicated by the circumferential scribe made at the exit point of the rear leading edge during breakdown.
4. Pull the sail down the leading edge and reinstall the mylar if removed. The mylar is most easily installed by attaching it to a long pole and pushing it into the pocket.
5. Reinstall the top side wire if removed.
6. Remount the sail to the rear leading edge, making sure to align the sail mount webbing squarely in the slot and attach the securing velcros. Again, you may find it helpful to use a large, flat blade screwdriver to pry the webbing over the end of the leading edge and into the slot.

The sail is mounted to the leading edge by the inner (forward) of the two loops of webbing. The outer loop is a pull handle only.

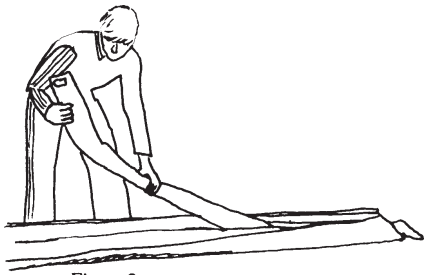
Ultra Sport Set-Up Procedure

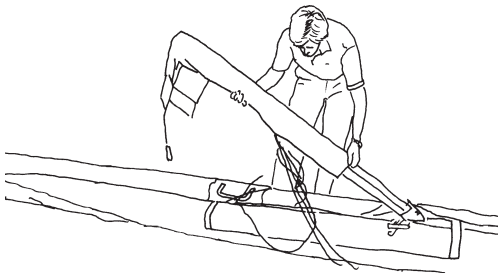
The Ultra Sport has been specially designed to set up quickly and easily either on the control bar or flat on the ground. We will first cover the steps for setting up on the control bar.

1. Lay the glider on the ground, with the bag zipper up, with the nose into the wind.



2. Undo the zipper and remove the battens. Slide the neoprene sock at the end of the keel tube forward until the end of the keel is exposed. Slide the neoprene sock covering the rear wire junction aft until the wire junction is exposed. Remove the control bar bag.





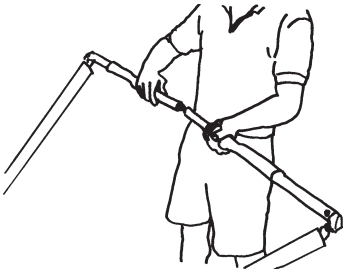
3. Unfold the control bar legs.

    a. If the glider is equipped with a folding basetube:

        i. Straighten the fold in the folding basetube.

        ii. Preflight the folding basetube center hardware at this time, checking that the nuts and coil spring pins are secure, and that the tangs are straight and in good condition.

        iii. Slide the basetube center sleeve over the center joint until it is positioned between the button spring pins. (Note: If you plan to clamp instruments to the basetube center, position the center sleeve so that one button passes through the hole near one end of the sleeve, which will secure the sleeve against rotation.



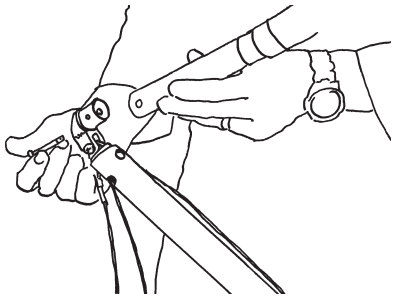
    b. If the glider is equipped with a non folding basetube:

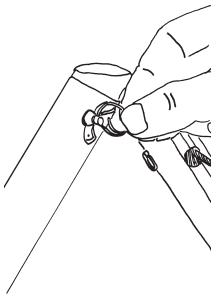
        i. Remove the safety ring, wing nut and bolt from the corner bracket.

        ii. Insert the corner bracket all the way into the basetube.

        iii. Install the bolt, wingnut and safety, securing the bracket to the basetube.

Make sure that the aluminum fitting is fully inserted into the basetube, and that the bolt is through both the basetube and the fitting. If the hole in the fitting can be seen outside the end of the basetube, the fitting is not fully installed, and will likely disengage in flight resulting in a dangerous structural collapse and loss of control of the glider.

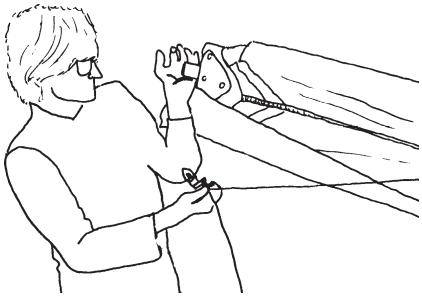


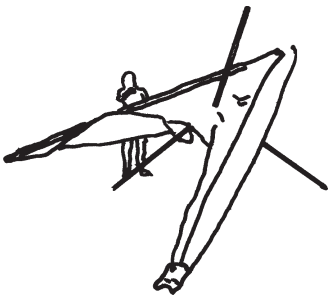


Do not insert the fitting at an angle, and do not force the fitting into the basetube if it does not slide in freely. Check for dirt or damage to the fitting or the inside of the basetube. If the fitting is forced into the basetube, it may be impossible to remove. See your dealer if the fitting becomes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

4. Flip the glider upright on the control bar, and remove the bag and all the velcro ties. Do not remove the leading edge tip protector bags at this time, but do loosen the velcros on the tip bags. If there is more than eight m.p.h. of wind, or if the wind is gusty, turn the glider 90 degrees to the wind direction.

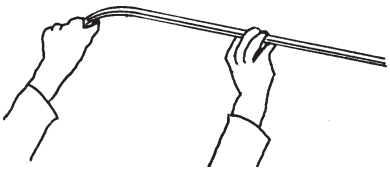
5. Spread the wings almost all the way. If you have left the bridles attached, this will automatically stand the kingpost upright. If not, lift on the top side wire as you spread the second wing, and the kingpost will stand up.





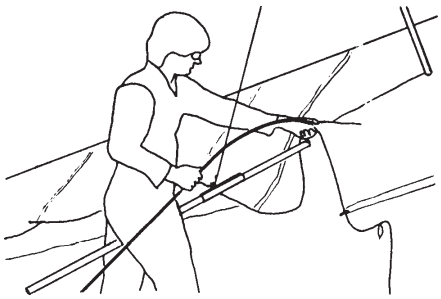
6. If the bridles have been detached, attach the bridle ring to the snap hook at this time, taking care that there is not a twist or rotation in the bridle ring which causes the bridle line to cross over one another.

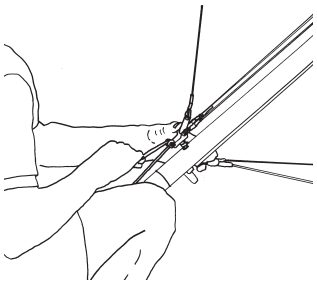
7. Remove the battens from the batten bag, and check each batten for symmetry against the corresponding batten from the other wing. Wills Wing convention is that black tipped battens go in the right wing and white tipped battens in the left, except for the straight #1 plug on battens which all have black tips.



8. Install the cambered top surface battens in the sail, leaving out the shortest three on each side (#2 - #4) for now. Each batten is secured by a double loop of the batten string. Order of insertion is longest to shortest, from the root out. When inserting the inboard most battens, lift the keel to ease the insertion. When these battens reach the back side of the leading edge tube, it may be necessary to lift the sail along the batten pocket to facilitate insertion of the batten all the way.

Insert the battens carefully, so as to minimize stress and wear on the sail. Never insert or remove top surface battens with the crossbar tensioned (except for up to the last four on each side) and never insert or remove battens with heavy wind pressure on the top of the sail or in any condition which causes the battens to slide with great resistance in the pockets. Take care that the rear edge of the mylar insert does not fold under when inserting the inboard most battens.





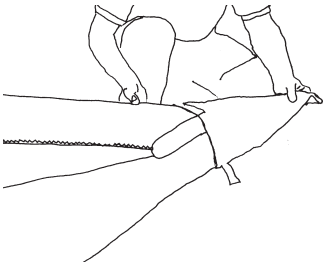
9. Spread the wings all the way and check all cables for any twisted thimbles or tangled cables. Check at this time that no bridle line is caught under the end of an adjacent batten.

10. At the rear of the keel, tension the crossbar by pulling on the top portion of the 4mm accessory cord which passes through the white pulley on the rear of the sweep wire keyhole channel. Drop the keyhole channel all the way down over the head of the keyhole bolt, and let it slide forward into the locked position.

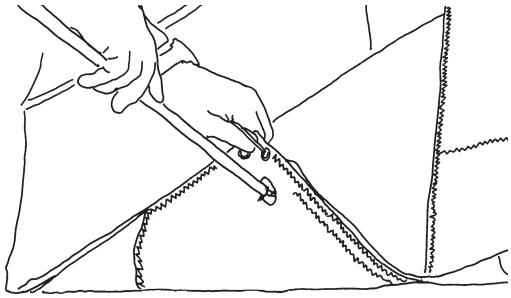
Never install the keyhole channel onto the keyhole bolt without making absolutely sure that the channel is fully engaged on the narrow neck of the bolt and slid forward into the fully locked position. An in-flight disengagement of this attachment will cause a complete loss of structural support of the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

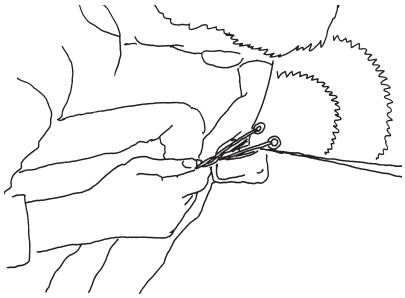
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11. Remove the wingtip protector bags. Install the last three curved battens on each side.

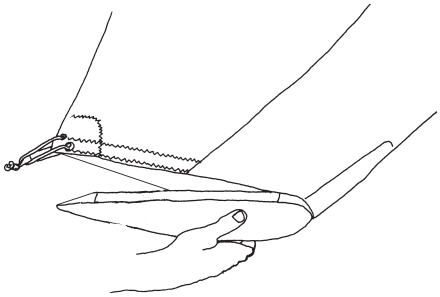


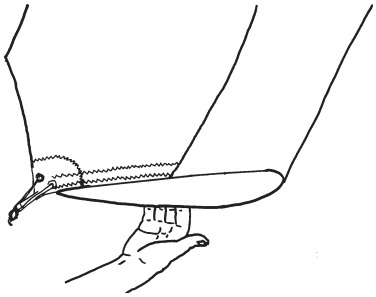
12. Install the plug-on #1 battens by inserting one end through the hole in the bottom surface at the tip and engaging the forked batten tip on the clevis pin standoff on the back side of the leading edge. Secure with a double loop of the 505 batten string.





13. 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 clevis pin and safety.
    c. The crossbar / leading edge junction bolt castle nut and safety.
14. Install the plastic wing tip fairing, or the optional winglet. Make sure that the fairing or winglet is fully inserted into the leading edge such that the velcro mates securely around the entire perimeter. While installing the tip fairing or winglet, support the aft tip of the number one batten as necessary so as to equalize the tension around the perimeter of the open end of the sail at the wing tip to insure that the sail mates properly to the tip fairing or winglet.

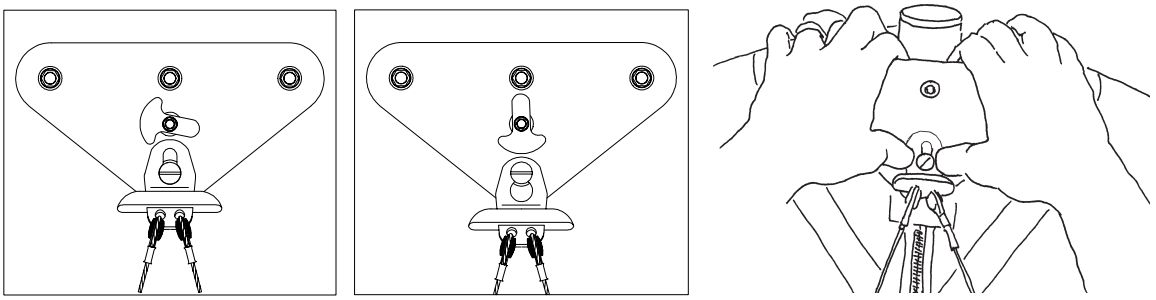




15. Attach the bottom front wires to the bottom of the nose. In order to attach or remove the keyhole tang from the collared bolt, the aluminum anchor lock must be rotated into the position shown below, left. Once this is done, install the keyhole tang over the collared bolt by pulling down on the nose of the glider while pressing the tang upwards over the collared 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.

Before attempting to install the bottom nose wires be sure that the control bar apex is pushed into place fully aft on the slider track. It should be secured in the full aft position by a clevis pin and safety ring on gliders manufactured before May, 1998 or the spring loaded Apex Slider Lock on newer gliders. Both the clevis pin and Apex Slider Lock configurations are illustrated in the assembly diagrams in back of this manual.

If you have difficulty installing the tang, the apex is fully aft, and no wires are twisted or thimbles cocked, it is probably because the glider is not sitting on level ground.



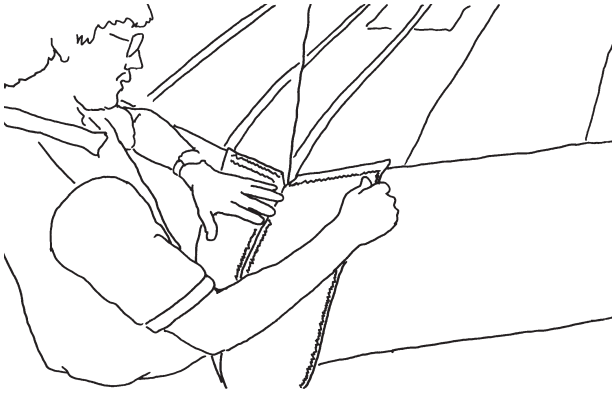
After installing the keyhole tang, rotate the aluminum anchor lock as shown to secure the tang on the bolt.

At this time, pre-flight the four 1/4 inch clinch nuts at the bottom of the noseplate assembly. Make sure that each is tight and fully engaged on the bolt exposing at least one complete thread past the edge of the nut. The engagement of the screw into the nut securing the keyhole safety lock should be at least flush with the edge of the nut.

If you are planning to truck tow or platform tow and are attaching a nose line in the vicinity of the noseplate, take special care that there is no way that the nose line can disengage the bottom front wire keyhole tang. Specifically, make sure the anchor lock is installed properly, and that any nose line is routed outside of and/or forward of the "V" of the bottom front wires.

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16. By lifting up and back on the nose batten strings, push the nose battens fully back into the sail so that the tips rest on top of the noseplate. Look into the noseplate and preflight the nosebolt nuts and the safety on the bolt securing the top front wire.
17. Install the nosecone taking care to align it so that it lies flat on the top and bottom of the sail.



18. Install the bottom surface battens.
19. Conduct a complete preflight of the glider, checking all assemblies which have not already been checked:

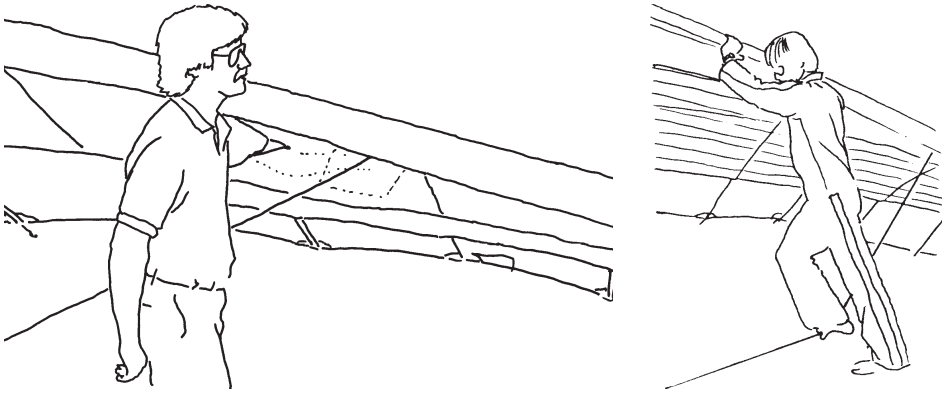
Preflight Procedure

Along the left leading edge

Carefully check the entire length of the leading edge pocket to insure that the mylar insert is lying flat in the pocket. If any section of the mylar is folded under, de-tension the crossbar, remove the batten closest to the area of distortion, and unfold the mylar.

Failure to correct folded under or severely creased mylar will cause a severe alteration of the flight characteristics of the glider which may lead to a dangerous loss of control.

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 may reveal a major structural defect that could cause an in-flight failure in normal operation.



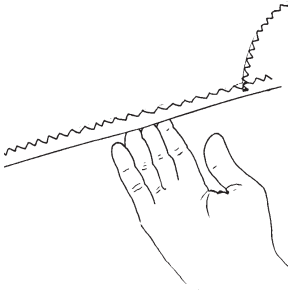
Open the crossbar junction access zipper and look inside, making sure that the safety ring on the junction bolt is in place and that the wires are secure and properly routed. Re-close the zipper.

At the left wingtip

You have already preflighted those parts of the glider accessible only with the tip fairing removed. At this time, check the tip again for secure and proper installation.

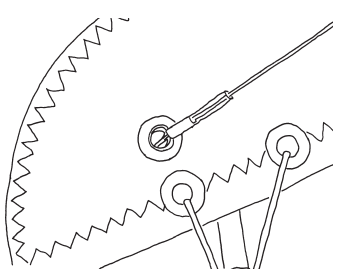
Along the trailing edge, left wing

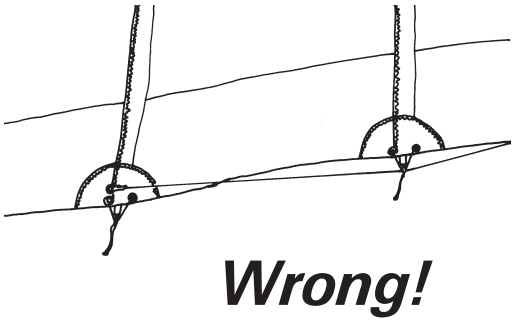
Check that there are no tears in the sail material along the trailing edge.



Check that all batten strings are properly secured.

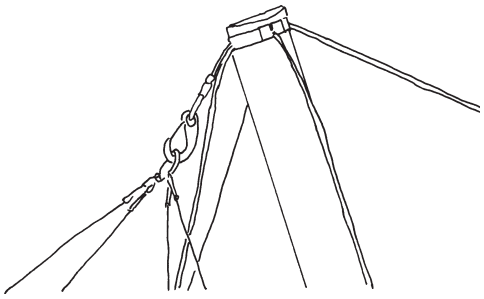
Check that the bridles are properly engaged, with the plastic retainer balls fully seated against the grommet, and that no bridle cable is hooked underneath a more inboard batten.





From the rear keel

Pull the top edge of the seal away from the kingpost and check the safety on the clevis pin which secures the kingpost to the bracket. Stretch the elastic webbing seal fully upwards along the kingpost.



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

Check the kingpost top for proper attachment of the bridles.

Check again that the keyhole channel is fully engaged and locked to the keyhole bolt.

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 there are no kinks or twisted thimbles. Check for proper installation of all nuts and safety rings at the control bar corners.

Check the two nuts on the top of the adjustable CG kingpost base bracket which secure the bracket to the keel.

Check the control bar base bracket pulley for free rotation. Overtightening of the mounting bolts will

cause this pulley to bind. Check the routing of the VG rope around the keel mounted base bracket pulley. Unzip the center zipper and check that the routing of all VG ropes and pulleys is clear and straight.

In particular, check that the rope attached to the traveling pulley is not caught under the crossbar hold down strap, and that the return rope from the nose to the kingpost base pulley is not wrapped around the triple blocks.

On models equipped with the CAM VG system, it is possible for the VG activation cable which runs along the leading edge to become caught under the front end of a bottom surface batten pocket. This is most likely to happen if the bottom surface battens are installed before the crossbar is tensioned. You should therefore be sure to install the bottom surface battens only after the crossbar is tensioned. Also, during the preflight, before cycling the VG system, you should check specifically to see that the VG cables on each side are not caught under the front of any bottom surface batten pocket.

Check the VG operation - the pull should be light and the return on release should be positive. On the 135 nd 166 with the cam VG system, the VG will not retract all the way when the glider is on the ground. You can retract it manually by reaching into the double surface and pulling the front triple block towards the nose.

Check that the front keel pocket is secured to itself with the mating velcro surfaces, and that all VG cables and ropes are inside the keel pocket.

Whenever you undo the velcro attaching the two sides of the front keel pocket to one another, you must be sure when reattaching them that the sweep wires are fully inside the keel pocket. Otherwise the keel pocket can be ripped away from the sail.

Pull back the neoprene protectors and 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 slider bolt and nut.

Inspect the apex slider to verify that the ears have not been bent in a hard landing, and that the bottom and side plastic slides are properly in place.

Check the main and backup hang loops

a. Check that the longitudinal CG track adjustment pin is secure and that the safety ring in is good condition.

b. Pull down firmly on the main loop and make sure that the webbing is not caught on the edge of the keel CG track.

c. Check that the backup is properly positioned between the VG pulley mount and CG track and does not interfere with the main kingpost hang loop thoughout the pitch range.

d. Check that the VG rope passes inside the main and outside the back-up hang loops.

e. Check the nut on the bolt that attaches the hang loop to the kingpost.

f. Check the clevis pin and safety ring which secure the control bar apex slider in the full aft position. On newer gliders, verify that the spring loaded apex slider lock is engaged in the slider assembly.

Laying the Glider Down Flat

Once the glider is assembled it can easily be laid down flat on the ground.

Disengage the spring loaded apex slider lock from the slider assembly. On older gliders, remove the clevis pin from the control bar apex slider to allow it move forward on the track. If the control bar apex is is not released from the aft locked position, the sidewires will become extremely tight as the control bar is rotated back and damage to the sail and airframe may occur.

Loosen the back-up hang loop to allow the control bar top to slide forward on the keel track. Detach the bottom of the nose cone. Disengage the keyhole tang (front wires) from the nose bolt. Pull the control bar apex all the way forward on the slider track. Lift the nose of the glider and rock it forward over the control bar, and then lay it down.

Reverse the procedure to set the glider upright again.

Setting the Glider Up Flat on the Ground

In areas where the ground is not rocky and when there are strong winds, you may wish to set up the glider flat on the ground. This is easy to do, and relatively few parts of the set up procedure are different from what has been described.

1. After unfolding the control bar and securing the basetube center sleeve, disengage the spring loaded apex slider lock from the slider assembly. On older gliders, remove the clevis pin from the control bar apex slider. Slide the control bar apex forward on the keel track. Flip the glider over right side up with the control bar still flat under the glider.
2. Spread the wings and install all the battens and the wingtips. (Note: Perform all the normal pre-flight operations as described above).
3. Tension the crossbar.
4. Attach the bridles
5. When ready, raise the nose of the glider and pull the control bar forward under the glider. Push the control bar apex fully aft, and secure the bottom front wires.
6. Install the clevis pin and safety which secure the apex slider in the full aft position.
7. Install the nosecone.

Launching and Flying the Ultra Sport

Before launching, hook in to the glider and do a careful hang check.

1. We recommend that you launch with the VG set between full loose and 1/3 on. A looser VG setting gives better roll control once airborne. On the 147, the looser the VG setting the more slack in the side wires, which reduces control of the glider while on the ground.

   If you launch with the VG set partly on, you must make sure that there is no way that the excess VG rope can catch on anything on the ground or that you can step on it. One way to do this is to fold the rope into a flat loop about eight inches long, and tuck it around the outside of the right downtube above the bottom front, rear, and side wires.

   If the wind is more than 10 m.p.h. 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. 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 Ultra Sport are typical of a high performance 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.

Minimum controllable airspeed and 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 MSA) and minimum controllable airspeed (MCA). *The more 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 MSA 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. MSA 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 MSA 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

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.

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. The tufts have been placed on your wing at the approximate location of the first onset of stall. 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 will have indicated reversed flow.

The first onset of 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. 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 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 MSA 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.

Also be aware that in some thermalling situations, such as when trying to maximize climb rate in a thermal with a very strong and very small core, there may be an advantage in overall effective climb performance to flying so slowly that some portion of the inside wing is partially stalled most of the time. This is, however, an advanced and potentially dangerous technique - it is the beginning of a spin entry, and if pushed just a little too far can result in a sudden and extreme loss of control and / or altitude. In general, if the tufts are indicating flow reversal associated with the stall, you will improve both performance and controllability by pulling in and speeding up a little.

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 yarn 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. If your hang loop is too far aft, it will make the glider more difficult to control in roll, especially in turbulent air and when the nose pitches up on entering a strong thermal.

On the Ultra Sport, hang loop fore and aft position is adjusted by repositioning the kingpost base bracket in the keel mounted CG track. The bracket is secured by a clevis pin and safety ring. The assembly is illustrated in the diagram ***Ultra Sport Middle and Rear Keel*** in the back of this manual.

We recommend that you not stow your glider bag, or any other cargo on the glider. The practice of putting your glider bag inside the sail, 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 a Hall Airspeed Indicator

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

There are four color coded bands on the ASI:

White: This is the range from 18 m.p.h. to 28 m.p.h.. This is the normal thermalling speed range for light to moderate thermalling conditions. Try to keep your speed within this range when thermalling in light to moderate conditions. Very strong or turbulent conditions will warrant a faster flying speed.

Green: The top of the green region represents the placarded maximum rough air and maximum maneuvering speeds. This speed of 46 m.p.h. should not be exceeded except in smooth air, and no abrupt large control deflections should be used above this speed. In significant turbulence it is recommended that you keep the airspeed "in the green" for best control and stability and best structural margin at all times.

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.

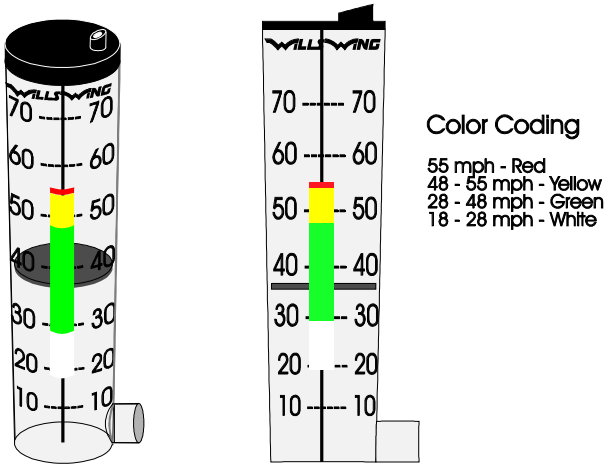
Red Line: This is your never to exceed speed. At no time should you fly faster than this speed.

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 certain operating limitations:

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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.



Using the VG System

The Ultra Sport 147 VG system uses a 14:1 reduction system of pulleys to allow for up to a 3.0 inches rearward adjustment of the crossbar center and up to a 2 degree increase in the airframe nose angle.

The Ultra Sport 135 and 166 VG systems use a 7:1 pulley reduction linked to a lever system located at the crossbar-leading edge junction. This system can adjust the airframe nose angle up to 3.5 degrees with out changing the crossbar center location, sidewire tension or airframe dihedral.

Tightening the VG increases the spanwise tension which the airframe places on the sail, reducing the spanwise twist and the sail elasticity. The result is an increase in L/D performance and a reduction in roll control authority and roll control response.

The VG is activated by pulling laterally on the VG rope and then moving the rope aft to set the rope in the V-cut knife cleat. The recommended procedure for increasing VG tension is to grasp the rope firmly at the cleat, and pull straight across behind the basetube.

Like other Wills Wing VG gliders, and unlike some other makes of gliders, the full loose setting of the VG on the Ultra Sport is intended to be used. This setting does not represent a degraded performance tuning configuration. VG full loose is a very useful configuration for maximizing control ease and response while retaining excellent performance. It is the recommended VG setting for working lift when any significant degree of turbulence is present, or when you are in proximity to terrain or other aircraft.

Between VG full loose and VG one half, the glider retains good ease of control and control response. Tighter than VG one half, the glider's roll pressures increase significantly and the roll rate becomes significantly slower. Tighter VG settings are recommended for straight line gliding, or for flying in smoother conditions when well clear of both the terrain and of other gliders. The stall characteristics of the Ultra Sport at tighter VG settings are more abrupt and less forgiving. Full breaking stalls at tighter VG settings are not recommended.

Note: The VG is approximately linear on the 147; when half the rope is pulled, about half the nose angle change has been effected. On the 135 and 166, the VG is non-linear; a true one half VG setting is achieved when approximately 2/3 of the rope has been pulled.

Flying Fast Without Oscillations

The Ultra Sport has some degree of susceptibility to high speed roll / yaw oscillations, as do all high performance gliders. By using proper flying technique, these oscillations can be avoided or reduced. They are not "pilot induced" as they are sometimes called, but they can be "pilot controlled." Specifically, what is required is that you fly "ahead of the glider" instead of "behind the glider." Flying ahead of the glider means being able to sense, by feel, what the glider is about to do in the future rather than observing what the glider has already done. You must be sensitive enough to the glider that you can feel that the glider is about to begin veering to one side, and you must be sensitive enough to be able to feel that the glider is beginning to respond to a correcting control input. Without this sensitivity, you will instead only be able to respond to your observation that the glider has actually changed heading. By the time the glider has actually changed heading, the control input to correct is too late.

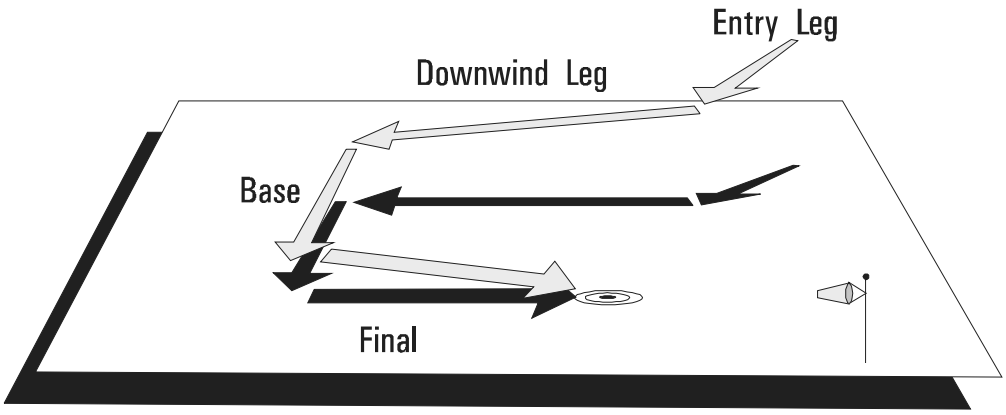
For example, if the glider gives an indication through pressure in the control bar that it is about to veer towards the right, the you should immediately respond by inputting a weight shift correction to the left. The glider at this point hasn't changed heading. By applying the proper left control input, you will prevent the change in heading. Then, however, you must be able to feel the glider's diminishing tendency to veer right (experienced as a reduction of roll bar pressure as the glider begins to respond to the left control input), and then immediately re-center on the control bar.What pilots tend to do instead is to input the left correction only after the glider has actually veered to the right, and hold the correction until the glider's heading has returned to the original desired heading. The glider in this case will way overshoot the desired heading, and the oscillation process has begun, and will continue to get worse as long as the pilot continues to input corrections in response to what the glider has already done instead of what it is about to do. The other thing pilots often tend to do is to respond to any perception of loss of control by gripping the bar more tightly and pulling in for more speed. Both of these will only aggravate a roll/yaw oscillation, as the glider becomes more subject to oscillation the faster one flies, and the pilot loses all feel for the glider by tightening his grip.There is no way to develop the sensitivity required to execute these techniques properly, except by lots of experience. There is a set of techniques that you can use, however, to achieve some measure of the same results. First, at any time that oscillations are beginning to get out of control, immediately put the bar at the normal trim position in pitch (slow down to trim speed) and center yourself on the bar. The glider will recover to normal flight right away. Second, when flying fast, if the glider begins to veer to one side, make a quick, sharp and deliberate weight shift in the opposite direction, and then immediately return to the center of the bar (without waiting for the glider to respond). If the first correction of this type isn't enough, do another one, but don't hold the correction longer. This technique approximates the proper technique of flying ahead of the glider by feel, without requiring the same degree of sensitivity.

The use of optional winglets increases yaw stability and damping and reduces the tendency to oscillate at all speeds. Winglets also slightly increase roll pressures and slow the roll rate. The use of a tighter VG setting when flying fast reduces the roll sensitivity of the glider and reduces the tendency to oscillate. Finally, there is an optional vertical stabilizer available for the Ultra Sport which significantly increases yaw stability and damping, and is very effective at reducing oscillations.

Landing the Ultra Sport

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. Making your approach with the VG set at between full loose and 1/3 on will increase your lateral control authority and shorten the length of your final "float" and is therefore recommended, especially in light winds when landing in a smaller field. 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 m.p.h., if the slope is steeper than 12:1, you should seriously consider landing downwind and uphill; or crosswind and across the slope.

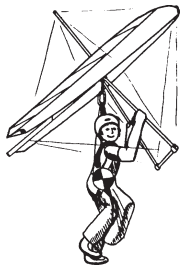
Standard Aircraft Approach Pattern

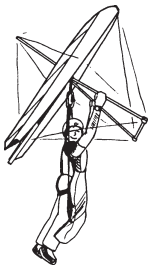


Making your approach VG full loose to VG 1/3 will also increase the glider's roll sensitivity, and some pilots have had difficulty with roll yaw oscillations on final. The best way to avoid this is to fly your entire approach at a constant airspeed, and to control your touchdown point by making adjustments to the shape of your pattern. In particular, you should avoid the technique of making a diving turn onto final. This maneuver, sometimes called a "slipping turn" is often taught to hang glider pilots as a way to lose altitude during the approach. It works reasonably well with low 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 over-shooting the intended landing point and the prospect of roll / yaw oscillations which may interfere with a proper landing.

On final approach, fly the glider down to within just a few feet of the ground, and bleed off excess speed in ground effect while keeping the wings level and the nose into the wind. Your body position should be inclined with your head and shoulders forward and your feet and legs trailing behind, with your hands at shoulder width and shoulder height on the uprights. As the glider begins to settle in a mush, and before you have extended your arms significantly, give a sharp aggressive flare pushing

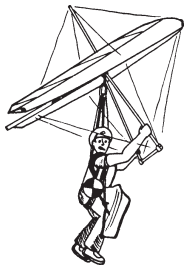
your arms and shoulders forward and your hips, legs and feet backwards. The braking effect of the flare will allow your feet to swing under you as the glider's forward motion is arrested.

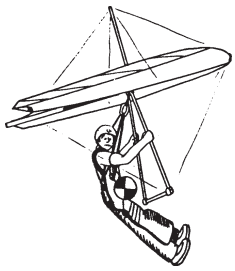




Note: Landing in a significant wind does not require a substantial landing flare; the pilot merely slows to near zero ground speed and touches down. The proper flare in light or no wind conditions is a dynamic action which causes a sudden and severe pitch up rotation of the glider. Pilots who have trouble 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 much extended to allow enough flare amplitude.

Note: One other technique you can try that will increase your landing flare authority is to land with some amount of VG on. With more VG on, the glider stalls more abruptly, and an abrupt stall is crucial for an effective landing flare. (A failure to fully stall the glider is what causes it to want to continue flying forward over your head, forcing you to run out the landing or have the glider nose in.) Having some VG on also dampens the glider's response in roll, which may help you avoid roll / yaw oscillations during your approach. There are some disadvantates to landing with VG on. The reduction in roll response, especially at low speeds, may make it more difficult to maintain directional control and a wings level attitude. The glider will glide farther in "ground effect" making it more likely for you to overshoot your intended target. For these reasons, it is not recommended that you land VG on in a tight landing area, or if there is significant turbulence that extends all the way to ground level. In a large landing area, extended float after round out is not a problem, so you can fly your approach at a higher speed. Flying faster gives back some of the roll response lost to the tighter VG setting. You can experiment with different VG settings to find the one that works best for you in a given set of conditions.

Ultra Sport Breakdown

Breakdown of the glider is the reverse of assembly.

1. Remove the nosecone and put aside. Remove any instruments.
2. Detach the bottom front wires at the noseplate. Pull the nose battens off the front of the top noseplate.
3. Remove the wingtips, the number one through number four battens, roll the sail at the wingtips and install the wingtip cover bags. Store the tip fairings one inside the other and place between the leading edges aft of the keel after the glider is in the bag.
4. Detension the crossbar and remove all the remaining battens, including the bottom surface battens, (but not including the nose battens).

4.1 For the 135 and 166, extra care is required to prevent sail and airframe damage from the front triple block pulley during breakdown and transport. Pull all of the slack rope out of the VG system between the triple blocks by pulling on the rope between the the crossbar center and control bar top. That prevents the front block from falling between the leading edge and the keel as the wings are folded in.

5. Fold the wings in pulling the sail over the top of the leading edges. Slide the neoprene sock at the end of the keel tube aft until it covers the end of the tube. Slide the tailored neoprene sock forward to cover the keyhole bolt at the aft wire junction.
6. If you leave the bridles attached, make one more fold in the sail bringing the trailing edge towards the keel. Roll the sail gently and carefully, and install the velcro sail ties.

Do not attempt to stuff the sail between the mylar pocket and the leading edge tube at any point behind the kingpost base. The internal fabric ribs prevent this. Because of the fabric ribs, the rear edge of the mylar pocket in the last 1/3 of the leading edge has a strong tendency to become creased at the rear edge of the mylar insert. To prevent this it is necessary to roll the aft part of the sail very gently, install the aft velcros loose, and then, as a final step, work your way along the rear edge of the mylar pocket as far down towards the tip as possible, pulling the sail behind the mylar pocket away from the leading edge so that the mylar pocket lies flat and is not curled under at the rear edge.

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7. Install the glider bag. Flip the glider over onto the ground.
8. Fold up the basetube. Replace all protective bags as you pack the glider away.

When folding in the optional folding basetube take care to avoid the following two problems:

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a. Do not fold the basetube together with the center sleeve not fully retracted from the center hinge. You will damage the sleeve.
b. Do not fold the basetube together with your hands or fingers around either the basetube or the lower portion of the downtube. It will hurt.

Ultra Sport Stability Systems

Several design features of the Ultra Sport determine the glider's degree of stability in pitch:

a. The combination of wing sweep and spanwise twist.

b. Reflex in the root section, the degree of which is determined by the lengths of the kingpost, control bar, and front to rear top and bottom wires, by the shape of the root battens.

c. Reflex support bridles running from the kingpost to the trailing edge at the number four, five, six, and seven (and eight on the 166) battens.

d. The shape of the preformed battens and the internal fabric ribs, and adjustment of the internal velcro attachments which define the airfoil.

e. A bridle compensation system on the 135 and 166 that is linked to the VG activation mechanism.

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

Ultra Sport Reflex Bridle Adjustment and Flight Testing

Bridles are an integral part of a system to provide pitch stability on the Ultra Sport. The Ultra Sport 147 uses four reflex support bridle lines per side (8 total) and the 166 uses five reflex support lines per side (10 total). These lines run from a ring which connects at the top of the kingpost through grommets in the sail to a ball retainer on the underside of the trailing edge. Their function is to support the trailing edge of the sail at low angles of attack, and thus provide a nose up pitching moment.

The variable geometry system on the Ultra Sport 147 functions by moving the center hinge connection of the crossbar assembly aft along the keel, thus pushing the leading edges outward and increasing the airframe nose angle. The variable geometry system on the Ultra Sport 166 functions by activating levers mounted at the outboard end of each crossbar to achieve the same result. Both mechanisms result in increased spanwise sail tension and a reduction in spanwise twist.

Depending on the VG mechanism, two possible effects result from engaging the VG which contribute to a tightening of the bridle lines. The first, which occurs on both the 147 and 166, is a flattening of the upward curve of the trailing edge of the sail. The second, which occurs only on the 147, is a downward folding of the wings around the axis of the keel, which occurs because the airframe nose angle widens, but the bottom side wires do not get longer.

Although the Ultra Sport 166 is only subject to the first effect, the bridle tightening from this effect is more pronounced because the VG range is much wider. As a result, the Ultra Sport 166 is equipped with a bridle compensation system which adjusts bridle length corresponding to VG setting.

Bridle measurement

As a preliminary check of the bridle adjustment, you can measure the effective bridle length settings. The glider must be fully assembled to measure the bridles. Set the glider to VG loose. At each bridle station batten, stretch a thread tightly across the trailing edge connecting the bridle station batten with the corresponding batten on the other side, (four threads on the 147, five on the 166.) Each thread should end in a loop which is looped over the batten tip, and each thread should be tensioned so that the

thread is straight and aligned with the batten center line. Then measure the height above the top of the keel tube of each of the threads at both VGL and VGT settings. Note: Battens are numbered from the tip inwards - the #2 batten is the shortest cambered batten.

VG Setting	Outer #4 Batten	Mid Outer #5 Batten	Mid Inner #6 Batten	Inner #7 Batten	Inner 166 only #8 Batten
Ultra Sport 135					
Loose	6"	5-7/8"	5-1/8"	3-7/8"	na
Tight	4-3/4"	4-3/8"	3-3/4"	2-3/8"	na
Ultra Sport 147					
Loose	3-5/8"	4-1/4"	4"	3-1/4"	na
Tight	5-1/8"	5-1/2"	5-1/8"	4-1/8"	na
Ultra Sport 166					
Loose	7-7/8"	8-1/8"	7"	6-1/2"	6-1/4"
Tight	5"	5-3/8"	4-3/8"	3-3/4"	3-3/8"

Test flight and checking the bridles

Following the initial adjustment of the bridles by these procedures, the glider must be flown, and the bridle adjustment evaluated in the air. Verification of correct bridle setting is done by flight testing to sight the shadow of the bridles on the sail. The bridles sight correctly when they meet the following sighting criteria only at VG full tight setting. It is not possible to verify the bridle adjustment at other than VG tight setting. The Ultra Sport 147 does not have a bridle compensation system—at VG loose the bridles will appear quite slack. The Ultra Sport 135 and 166 do have a bridle compensation system, however the bridles will still be slacker at looser VG settings.

VG Setting	Outer #4 Batten	Mid Outer #5 Batten	Mid Inner #6 Batten	Inner #7 Batten	Inner 166 #8 Batten
Tight	Just Slack	Just Slack	Snug	Snug	Snug

In order to sight the bridles, use the following procedure:

For each VG setting, check the bridles by flying multiple, shallow banked turns at minimum sink speed, sighting the shadow of the bridles on the sail as the glider turns to the proper orientation to the sun.

To sight a bridle line, shake the control bar sharply in pitch with an amplitude of four to six inches. Watch the response of the bridle line, and judge the adjustment as follows:

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.

If the bridles are set too loose, it may cause a reduction in pitch pressures at tighter VG settings, and there will be a reduction in pitch stability at angles of attack below normal flight. This stability reduction could increase the probability of a turbulence induced tumble or other in-flight stability related loss of control. Although we have stressed in our owner's manuals for years the need to actively maintain proper bridle adjustment, it has become clear to us that this is not being adequately addressed on older gliders in the field. Many pilots assume that they should never change or adjust anything on their glider, and prefer instead to leave it "in the factory settings."

The problem with this is that a glider which is "left in the factory settings" does not, in fact, remain in a proper state of adjustment. With respect to reflex bridles, the glider will, all by itself, go out of adjustment to the point where it will no longer have the original pitching moment. In some cases, it may not even have a positive pitching moment at the critical angles of attack near zero lift.

Normal Bridle Adjustment Methods

On the Ultra Sport 147, the bridle ring can be raised, tightening the bridles, by replacing the bridle "pigtail" cable which exits from the rear of the kingpost top. You can use leech line to tie up the ring at various higher settings until you achieve the proper bridle adjustment, and then order a new pigtail through your dealer with a custom length such as, for example, "3/4" shorter than stock."

On the Ultra Sport 135 and 166, there is normally an extra tang in the rear attachment of the lower compensator wire to the keyhole channel which connects the sweep wires at the rear of the keel. Removing this tang will raise the bridle ring about 5/16". For larger adjustments, you can follow the procedure described above for the 147, except that the wire you are replacing is the upper compensator wire instead of the bridle pigtail.

Bridle Adjustment For Older Gliders

The above adjustment methods are adequate to correct for minor bridle misadjustment caused by stretching of the various cables and seating of the hardware. There is another mechanism by which bridle adjustment changes, for which the normal adjustment of the bridles will eventually be insufficient. Over time, as the glider ages, the sail shrinks in the spanwise direction along the trailing edge. The result is that the bridle attachment point moves inwards, and since the cables do not also shrink, the trailing edge moves downwards. In more advanced cases of this, the traditional method of adjusting the bridles by raising the bridle ring is insufficient to regain the original bridle adjustment and stability levels. One reason is that in severe cases of sail shrinkage, some portions of the trailing edge may be lowered as much as six inches, and the ring cannot be raised that amount without raising it above the top of the kingpost. Another is that the amount of sail shrinkage is greater over the greater distance to a further outboard bridle, which causes the outboard bridles to be lowered more, and results in the requirement that the outboard bridles be raised more than the inboard ones to regain the original adjustment.

In September of 1997, we conducted a vehicle pitch test series on a HPAT 158 with about 400 hours on it. Prior to making any bridle adjustments, we found that the glider retained a positive pitching moment at VG loose, though the pitching moment curve had a few areas where it failed to meet HGMA minimum requirements. At VG tight the situation was dramatically worse – the glider actually had a negative pitching moment at near zero lift angles of attack. After adjusting the bridles to the proper "just slack in (one G) flight at min sink" criteria, the glider passed all the HGMA pitching standards under which it was originally certified in 1989, as well as the somewhat more stringent standards in

effect in 1997. However, in order to achieve this adjustment, it was necessary to shorten the outer bridle cables by more than one inch – a level of adjustment that was far outside the range of adjustment provided by raising the bridle ring.

We have found the most effective method to adjust bridles which are grossly out of adjustment due to sail shrinkage is to shim the bridles from below the sail. Wills Wing will provide on request through your dealer a kit of tubular shims in 1/4", 1/2" and 1" lengths. By removing the bridle ball, sliding the tubing shim over the cable below the sail, and re-installing the ball, you can shorten the cable in calibrated amounts. Since it is difficult to sight the bridles accurately in flight unless you have a lot of practice at it, the most accurate way to achieve the "just slack" adjustment is to actually go a little too far, and adjust the bridles to the point of being snug (see the earlier descriptions of how to sight the bridles). Then by backing off ¼ inch or so from "snug" you will have "just slack." Use caution when making these adjustments, because as the bridles become tight, the glider's handling will deteriorate and the pitch trim will change. Once the proper bridle adjustment is achieved using the shims, you can order a custom made replacement bridle set fabricated to the proper dimensions, by specifying the total length of shims used to correct each bridle.

Maintenance

This section contains a recommended schedule of periodic maintenance. None of the items in this section are a substitute for the continual and consistent practice of proper pre-flight inspections and immediate maintenance of any items on the glider which require it. Safety requires that your glider be fully airworthy for every flight. Nuts and bolts must always be secure, safeties must always be in place, and damage to any part which could compromise the airworthiness of the glider cannot be tolerated. If you have a question about the need to repair or replace some part of your glider, feel free to contact your dealer or Wills Wing directly. It is not always obvious which items require attention and which may not. Minor dents or dings in a non critical location on an airframe tube may not require any repair or maintenance. On the other hand, a wire that has been kinked one time can fail very quickly after that, and should be replaced immediately. A control bar corner fitting that has had a significant landing impact may have a crack that is almost undetectable, but which could cause the part to fail catastrophically at a later time.

We recommend that you have all maintenance work done by your Wills Wing dealer.

Every month

1. Check your battens on a flat level floor against the batten diagram provided, and correct any that deviate from the pattern by more than 1/4".
2. 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.

Every six months

1. Have a complete inspection performed on the glider and replace any suspension system 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.
4. Disassemble basetube pulley assembly, clean, lubricate with white grease, and re-assemble.
5. Lightly spray all zippers on the glider with silicone spray lubricant. Also spray your battens before 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 silicone so that it does not attract dirt.

Every year

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. Inspect all holes, slots, bushings, etc, for any sign of cracking, elongation or fatigue. Anytime you have the sail off the frame, turn the sail inside out through the bottom surface center zipper and inspect all of the batten pockets and batten pocket terminations. Also carefully inspect the webbing loops which mount the sail at the rear of the leading edges, and have them replaced if they are worn.
2. Replace bottom side wires and hang loops.
3. Replace the VG ropes.
4. Replace and re-adjust all batten strings (see the tuning section on batten string tension).

Special circumstances

1. Cleaning Your Sail - Keeping your sail clean will extend the life of the cloth. When cleaning the entire sail you should generally use only water and a soft brush. You may clean small spots or stains with any commercial 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.
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 and bushings, flushed liberally with fresh water, dried completely, and treated for corrosion inhibition with LPS-3 or other suitable agent.
3. 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. Following any hard landing, be sure to inspect the apex slider, the control bar legs and basetube, and all control bar fittings for damage. Any time you replace a control bar leg or basetube, you must carefully inspect all related fittings and replace any that are bent or damaged.

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 reinstalling 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 tangs from the bolts that tether the sail at the noseplate. Completely unzip and separate the bottom surface zipper. Remove the screw and disengage the webbing zipper stop at the bottom nose area.
3. 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.
4. Unbolt the bottom side wires from the control bar and feed them through the hole and into the sail. Detach the bottom front and rear wires from the control bar legs. Unbolt the control top elbows at the control bar apex from the apex slider on the keel. Unbolt the bottom rear flying wires from the rear keel. Reassemble 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 reassembled in the proper order and orientation. Use the exploded parts diagrams in this manual to help you.
5. Undo the velcro which holds the front part of the keel pocket together. Disconnect the front VG pulley from the retaining bungee keyring (135/166 only). Untie the VG activation rope from the becket on the rear triple block, and unthread the VG activation rope from the two triple blocks. Unthread the VG activation rope from the control bar downtube. Set the control bar aside. Detach the bridle compensator cable from the front pulley block by removing the clevis bolt (135/16 only)
6. 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.
7. 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. Reinstall the cap. Unbolt the kingpost from the base bracket on the keel. On the 166, disconnect the lower compensator wire. Set the kingpost aside.
8. Unbolt the tang which connects the webbing strap sewn to the rear of the sail to the rear keel. Unbolt the top rear wire and sweep wires from the keyhole bracket.
9. Feed the top side wires into the sail through the holes in the sail. Turn the glider over onto its back again. Slide the frame out through the open center zipper. If you encounter resistance, stop and find out what is hanging up.
10. If you need to send the sail into the factory for repair, remove the mylar. It is removed from the front end of the mylar pocket. It helps to secure the opposite end of the sail to something solid, so

that you can lay the leading edge out straight and pull the mylar straight out of the pocket. If you have trouble getting it to slide out freely, it is probably because the edge of the mylar has worked its way into the seam and gotten stuck on the adhesive seamstick tape. Work your way up and down the leading edge pocket rolling the mylar away from the seam until it is free along its entire length. Fold and package the sail carefully if you plan to ship it in for repair. 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.

Re-installing the sail on the frame

1. Install the mylar in the sail. (If the mylar pockets have been replaced you will need to trim the rear edge of the mylar by 1/2". Also, you will probably need to remove one 1/4" shim from the sail mount plug to mount the sail looser.) Make sure you install it right side up; the curved edge is at the front and on the bottom. The easiest way to install the mylar is to push it into the pocket using a long lofting batten attached to the end of the mylar insert which is first inserted in the pocket. A small diameter pin on the end of the lofting batten placed through a small hole in the end of the mylar insert allows you to push the mylar into the sail and remove the batten while leaving the mylar in place. You will have to stop from time to time to make sure the mylar is properly lying flat in the pocket. Do not push the mylar too far into the pocket; stop when the top side wire hole in the mylar lines up with the hole in the sail. Make sure there are no folds in the mylar, especially at the tips. Make sure the mylar wraps in the proper direction to follow the sail around the leading edge as it enters the pocket.
2. 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 mylar pockets lying on top.
3. 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.
4. 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 sail through the open bottom surface zipper, making sure that the leading edges of the frame 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.
5. After the frame is fully installed, attach the sail anchor tangs to the bottom noseplate hinge bolts. Install and adjust the clinch nuts to allow rotation of the tang. Align the axis of the tang with the leading edge.
6. Mount the webbing anchor loops over the rear leading edge endcaps. ***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. (Proper sail alignment is sometimes difficult to check at this time - recheck this when you do your fully assembled preflight of the glider). Secure the velcro retainer tabs.
7. Feed the top front kingpost wire through the hole in the sail.
8. Working through the camera mount zippers, insert the top and bottom side 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.

9. Bolt the bottom rear wires to the rear of the keel. Install the control bar legs onto the apex slider. Install the bottom front, bottom rear and bottom side wires to the control bar corners, attaching the basetube to the legs in the process.
10. Flip the glider up onto the control bar.
11. Reinstall all the top wires onto the kingpost.
12. 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.***
13. Bolt the kingpost to the base bracket on the keel. Connect the top rear wire and sweep wires to the keyhole bracket. Connect the bridles to the sail.
14. Reattach the rear sail mount to the rear keel.
15. Finish the assembly of the glider completely according to normal assembly procedures. Reroute the VG activation ropes and reconnect to the becket on the rear triple block.
16. Do a very careful and complete preflight of the glider according to the normal preflight procedure as explained earlier in this manual.

Glider 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 can be most easily accomplished by using a large, flat bladed screw driver to pry the sail mount webbing off of the end of the leading edge. The same technique can be used to reinstall the sail. Take care not to damage the sail mount webbing, and 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

This 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.

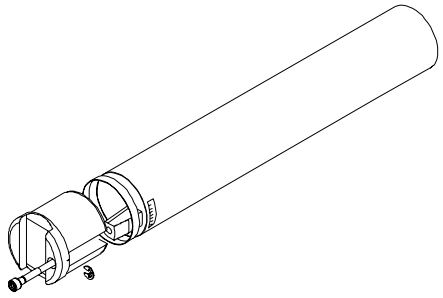
Check for symmetrical twist in the leading edges by checking for symmetry in the alignment of the sail mount plugs.

Battens

Check the battens for symmetrical shape and batten string tension.

Sail Mount Plugs - Adjusting Sail Tension and Rotational Alignment

In the allen screw type plug, the molded plastic 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 15 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 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, 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.

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. To remove the plug, 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. Fifteen turns of the allen screw after installation of the plug will secure the plug in place.

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.

If the cap screw backs out of the sail adjuster as you loosen it, it means that the circlip has dislodged from the groove in the screw. In this case you will need to tap on the end of the cap screw to disengage the wedge and free up the sail adjuster. You will then also need to dismount the sail, remove the sail adjuster, and replace the circlip. The original circlip can be reshaped and reused, or you can install a new one.

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 or equal to the wall thickness of the tube) in the rear leading edge tube adjacent to the screw.

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. You should be able to pull the string about 3/8" beyond the end of the batten tip, and when the string is set onto the tip the tension along the batten pocket should be just enough to pull most of the static wrinkles out of the sail, but not so tight as to cause the batten camber to push upwards causing a bulge in the sail. The outboard batten strings should be progressively tighter as you go towards the tip. The number one batten strings should be quite tight, and when they are properly adjusted you will not be able to install them unless the crossbar is tensioned. Note that the sail and batten strings will shrink over time, tightening the batten strings and adversely affecting the handling. You should replace and re-adjust all of your batten strings once per year.

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. As the glider gets older and the sail stretches, you will need to add shims to maintain the proper tension.

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, but not tied so tightly or with such a small diameter rope that the mylar insert is permanently deformed. 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.

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 AIRWORTHINESS STANDARDS
HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL: Ultra Sport 135
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 non-essential parts: 60
2. Leading Edge Dimensions
   a. Nose plate anchor hole to:
      1. Crossbar attachment hole 114.0
      2. Rear sail attachment point 203 - 204
   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 load bearing ball center at glider centerline 104.25 - 105.5
   b. Largest outside diameter 60mm main spar; 62mm end sleeves
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 34.0
   b. The pilot hang loop 49.5 - 52.0
5. Sail Dimensions
   a. Chord lengths at
      1. 3 ft outboard of centerline 66.0
      2. 3 ft inboard of tip 42.0
   b. Span (extreme tip to tip) 360.5 VGL - 364.8 VGT, inc tip fairings
6. Location of Information Placard Keel
   Location of Test Fly Sticker Keel
7. Recommended Pilot Weight Range 125 - 210
8. Recommended Pilot Proficiency USHGA Intermediate

HGMA AIRWORTHINESS STANDARDS
HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL: Ultra Sport 147
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 non-essential parts: 65
2. Leading Edge Dimensions
   a. Nose plate anchor hole to:
      1. Crossbar attachment hole 120.0
      2. Rear sail attachment point 215.25 - 216.25
   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 load bearing ball center at glider centerline 110.5
   b. Largest outside diameter 2.25
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 33.25 - 36.75
   b. The pilot hang loop 51.0 - 53.5
5. Sail Dimensions
   a. Chord lengths at
      1. 3 ft outboard of centerline 67
      2. 3 ft inboard of tip 40
   b. Span (extreme tip to tip) 392 inc tip fairings (VGT)
6. Location of Information Placard Keel
   Location of Test Fly Sticker Keel
7. Recommended Pilot Weight Range 150 - 250
8. Recommended Pilot Proficiency USHGA Intermediate

HGMA AIRWORTHINESS STANDARDS
HGMA COMPLIANCE VERIFICATION SPECIFICATION SHEET

GLIDER MODEL: Ultra Sport 166
MANUFACTURED BY: Wills Wing, Inc.
All dimensions in inches; weights in pounds.

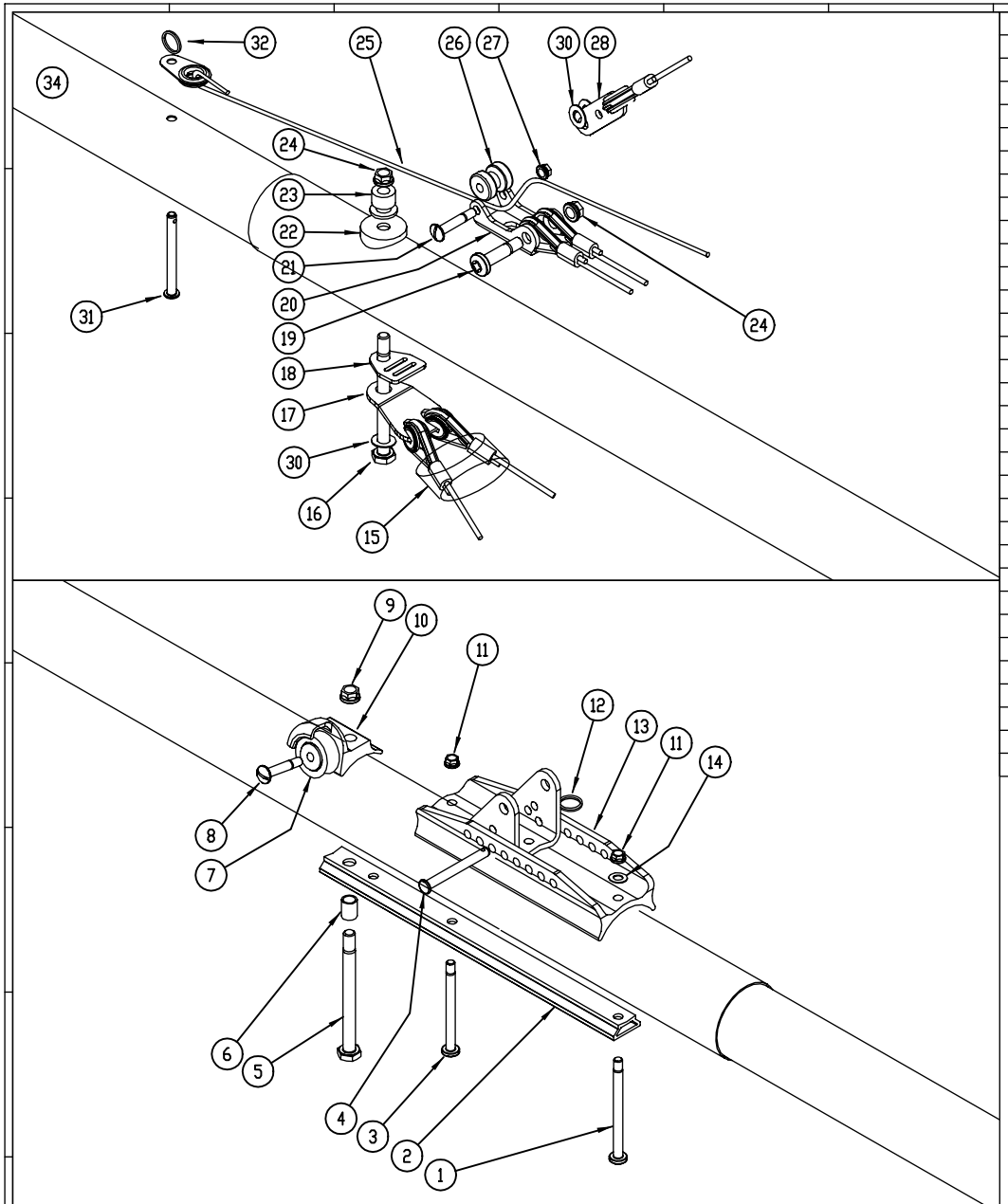
NOTE: These specifications are intended only as a guideline for determining whether a given glider is a certifIed model and whether it is in the certified configuration. Be aware, however, that no set of specifications, however detailed, can guarantee the ability to determine whether a glider is the 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 non-essential parts: 70
2. Leading Edge Dimensions
   a. Nose plate anchor hole to:
      1. Crossbar attachment hole 132.0
      2. Rear sail attachment point 227.5 - 228.5
   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 load bearing ball center at glider centerline 122.1 - 122.8
   b. Largest outside diameter 2.50
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 37.4
   b. The pilot hang loop 53.4 - 55.9
5. Sail Dimensions
   a. Chord lengths at
      1. 3 ft outboard of centerline 73.5
      2. 3 ft inboard of tip 45.5
   b. Span (extreme tip to tip) 403.5 - 409.5 inc tip fairings (VGT)
6. Location of Information Placard Keel
   Location of Test Fly Sticker Keel
7. Recommended Pilot Weight Range 175 - 285
8. Recommended Pilot Proficiency USHGA Intermediate

Ultra Sport 135, 147, 166
Assembly Diagrams
Table of Contents

Drawing ID	Drawing Description	Page No
82E01	Ultra Sport 147 Middle/Rear Keel	2
82E02	Ultra Sport 147 VG Assembly	3
82E03	Ultra Sport 147 Crossbar Assembly	4
83E04	Ultra Sport 147 Noseplate Assembly	5
82E05	Ultra Sport 147 Kingpost Assembly	6
84E01	Ultra Sport 135 and 166 Rear Keel	7
84E02	Ultra Sport 135 and 166 Middle Keel	8
84E03.1	Ultra Sport 135 and 166 Cam VG	9
84E04.1	Ultra Sport 135 and 166 Crossbar Center	10
84E05	Ultra Sport 135 and 166 Noseplate	11
84E06	Ultra Sport 135 and 166 Kingpost	12
80E06	VG Control Bar Assembly	13
82E07	VG Folding Basetube Assembly	14
82E09	Ultra Sport Rear Leading Edge Assembly	15
NA	Ultra Sport Control Bar Specifications	16
NA	Ultra Sport 147 Airframe	17
NA	Ultra Sport 166 Airframe	18
NA	Ultra Sport 135 Airframe	19
NA	Ultra Sport 166 Euro Airframe	20
NA	Control Bar Apex Button Lock	21

Ultra Sport 147 Middle/Rear Keel



ID	PART NO	DESCRIPTION	QNT
1	10C-4341	BOLT NAS 623-3-34	1
2	20G-2103	TRACK LAYFLAT CBAR APEX SHORT2	1
3	10C-4301	BOLT NAS 623-3-30	1
4	10G-1510	CLEVIS PIN MS20392-2C51	1
5	10A-2271	BOLT AN4-27A	1
6	10T-3100	SPACER SS .313 * .028 * .390	1
7	20P-1230	PULLEY HARKN SHEAVE TOP LEG VG	1
8	10B-1101	BOLT AN23-10A	1
9	10N-1740	CLINCH NUT 1/4 MS21042-4	1
10	20G-1510	BRACKET VG PULLEY KEEL MOUNT	1
11	10N-1730	CLINCH NUT 3/16 MS20142-3	2
12	10P-1100	SAFETY RING AN 9491 SMALL	1
13	20G-1312	CG BRACKET KP HANG 95	1
14	10U-1130	WASHER STEEL AN960-10	1
15	15A-1007	FRICTION CAP 7/8	1
16	10A-2301	BOLT AN4-30A	1
17	40P-3301	WIRE SET BOTTOM REAR BALL SWDG	1
18	20E-2321	TANG 1 HOLE 2 SLOT 5/8 WEBBING	1
19	10C-5121	BOLT NAS 623-4-12	1
20	20A-1601	BRACKET, KEYHOLE TYPE LAYFLAT	1
21	10B-1161	BOLT AN23-16A	1
22	15F-1602	STAND-OFF 1/8	1
23	20G-2901	COLLAR KEYHOLE TANG BOLT	1
24	10N-1740	CLINCH NUT 1/4 MS21042-4	2
25	45K-1502	XBAR PULLBACK ROPE - XC	1
26	15K-1001	PULLEY DELRIN KEYHOLE BRACKET	1
27	10N-1730	CLINCH NUT 3/16 MS20142-3	1
28	40P-2401	WIRE TOP REAR BALL SWEDG 3/32	1
30	10U-1140	WASHER STEEL AN960-416	2
31	10G-1570	CLEVIS PIN MS20392-2C57	1
32	10P-1100	SAFETY RING AN 9491 SMALL	1
34	15B-1612	ENDCAP 1 3/4 .049	1

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TITLE: Ultra Sport Middle and Rear Keel

PART NO:	DWG ID:	DOCUMENT ID:	REVISED:	DRAWN:	SCALE:
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T.U.S. .X ± .05
.XX ± .015
.XXX ± .003
.XXXX ± .0005
ANGLES ± 1/2°

ID	PART NO	DESCRIPTION	QNT
1	40P-5008	WIRE XBAR CENTER VG TRIPLE BLK	1
2	40P-4207	WIRE XBAR SWEEP XC SET SPREADR	1
3	20P-1211	PULLEY HARKN SINGLE W/SHACKLE	1
4	45K-1501	VG ROPE - XC LOWER	1
5	30J-3101	CORD - 4mm ACCESSORY PER FOOT	10

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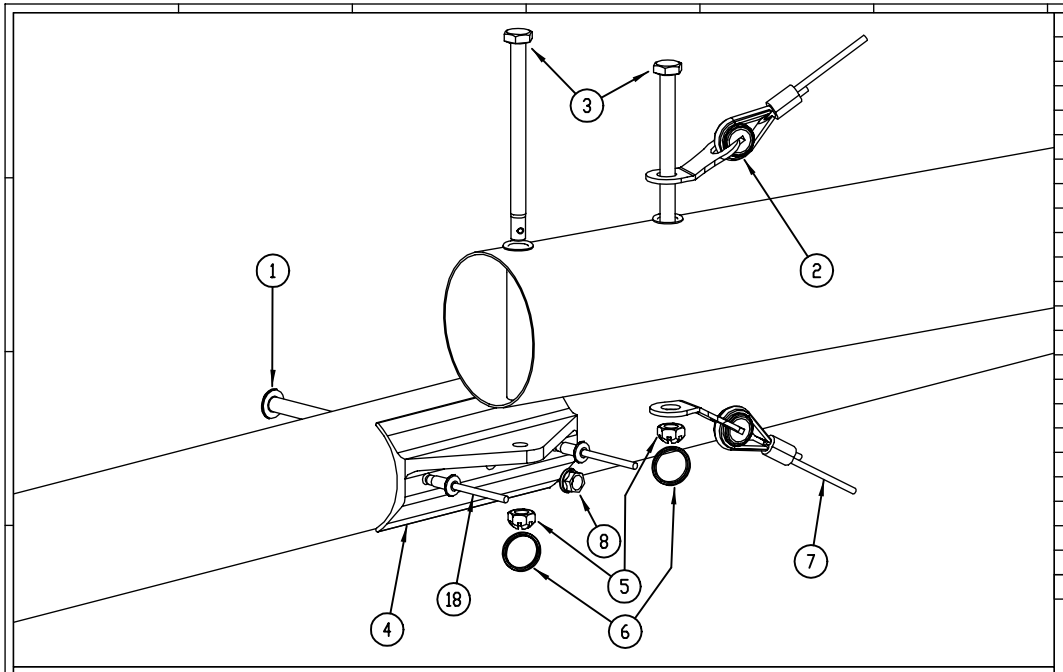
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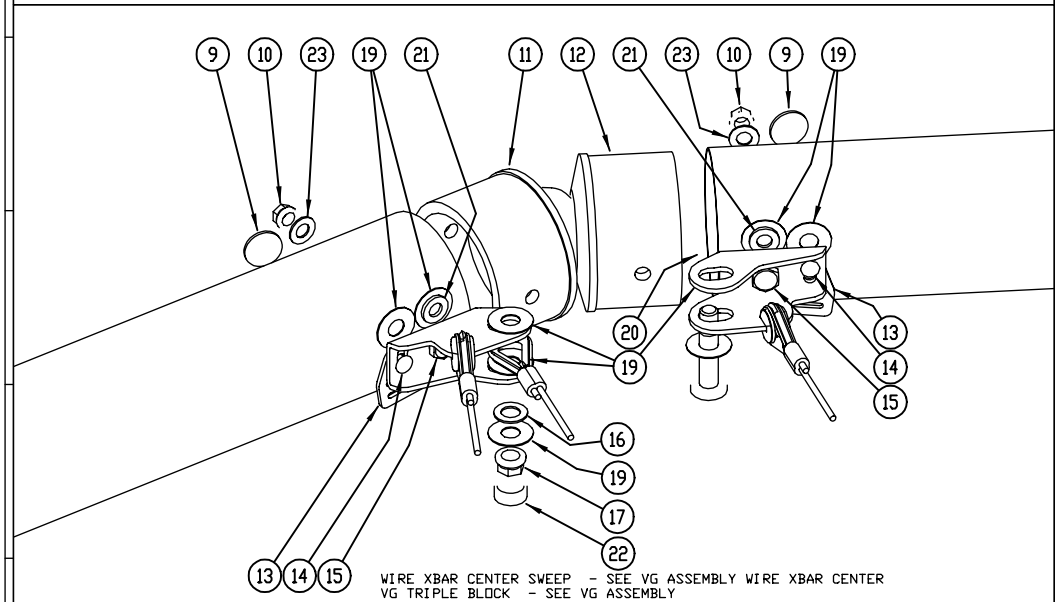
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DOCUMENT ID: 82E02
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DRAWN: 12-01-96 SP
SCALE: NA

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ANGLES ± 1/2°

Ultra Sport 147 VG Assembly

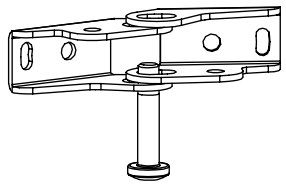
Ultra Sport 147 Crossbar Assembly





WIRE XBAR CENTER SWEEP - SEE VG ASSEMBLY WIRE XBAR CENTER
VG TRIPLE BLOCK - SEE VG ASSEMBLY

ID	PART NO	DESCRIPTION	QNT
1	10B-2400	BOLT AN24-40	2
2	40P-2202	WIRE TOP SIDE BALL SWEDGE 3/32	2
3	10A-2260	BOLT AN4-26	4
4	20G-1110	XBAR/LE BRACKET 52MM LDNG EDGE	2
5	10N-1340	CASTLENUT 1/4 AN310-4	4
6	10P-1100	SAFETY RING AN 9491 SMALL	4
7	40P-3103	WIRE BOTTOM SIDE 3/32 AT STYLE	2
8	10N-1740	CLINCH NUT 1/4 MS21042-4	2
9	10P-1100	SAFETY RING AN 9491 SMALL	2
10	10N-1740	CLINCH NUT 1/4 MS21042-4	2
11	15J-2116	SOCKET XBAR CNTR BALL JNT 2.25	1
12	15J-2126	BALL XBAR CNTR BALL JOINT 2.25	1
13	45K-1312	XBAR STRAP HOLD DOWN 155 SHORT	1
14	10G-1790	CLEVIS PIN MS20392-2C79	2
15	10A-2251	BOLT AN4-25A	2
16	10U-1151	WASHER STEEL AN960-516L	1
17	10N-1750	CLINCH NUT 5/16 MS21042-5	1
18	10R-0366	RIVET AL 3/16 * .375 CHAAPQ6-4	4
19	10U-5125	WASHER NYLON .75 * .316 * .020	7
20	10C-6171	BOLT NAS 623-5-17	1
21	10U-1140	WASHER STEEL AN960-416	2
22	15A-1103	NUT CAP SHALLOW	1
23	10U-1141	WASHER STEEL AN960-416L	2



RIGHT CROSSBAR HINGE BRACKET
MUST ALWAYS BE ASSEMBLED ON
TOP OF LEFT AS SHOWN ABOVE

WILLS WING
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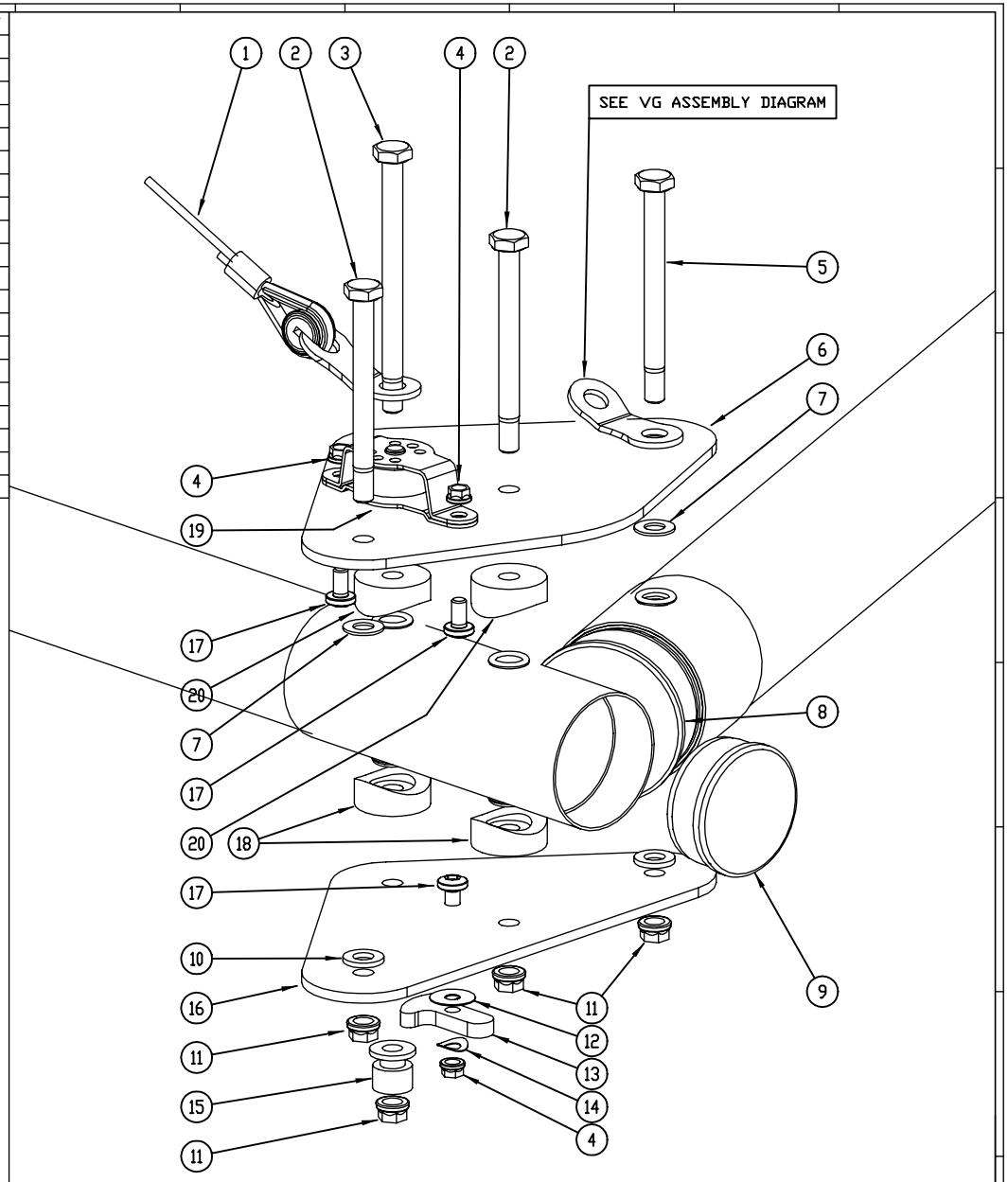
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T.U.S. .X ± .05
.XX ± .015
.XXX ± .003
.XXXX ± .0005
ANGLES ± 1/2°

Ultra Sport 147 Noseplate Assembly

ID	PART NO	DESCRIPTION	QNT
1	40P-2301	WIRE TOP FRONT BALL SWEDG 3/32	1
2	10A-2260	BOLT AN4-26	2
3	10A-2321	BOLT AN4-32A	1
4	10N-1730	CLINCH NUT 3/16 MS20142-3	3
5	10A-2271	BOLT AN4-27A	1
6	20C-1621	NOSEPLATE RAMAIR TOP EXTENDED	1
7	10U-1141	WASHER STEEL AN960-416L	2
8	15B-2012	ENDCAP 2 .049	2
9	15B-1612	ENDCAP 1 3/4 .049	1
10	10U-1140	WASHER STEEL AN960-416	2
11	10N-1740	CLINCH NUT 1/4 MS21042-4	4
12	10U-5093	WASHER NYLON .560 *.192 *.015	4
13	20C-1501	SAFETY ALUM KEYHOLE ANCHOR	1
14	10U-8010	WASHER WAVE KEYHOLE ANCHOR	1
15	20G-2901	COLLAR KEYHOLE TANG BOLT	1
16	20C-1611	NOSEPLATE HARRIER THRU CURRENT	1
17	10L-1061	SCREW PAN 3/16 MS35207-263	3
18	15F-1404	STAND-OFF 1/4	2
19	20P-1231	PULLEY HARKN CHEEK BLOCK VG	1
20	15F-1602	STAND-OFF 1/8	2

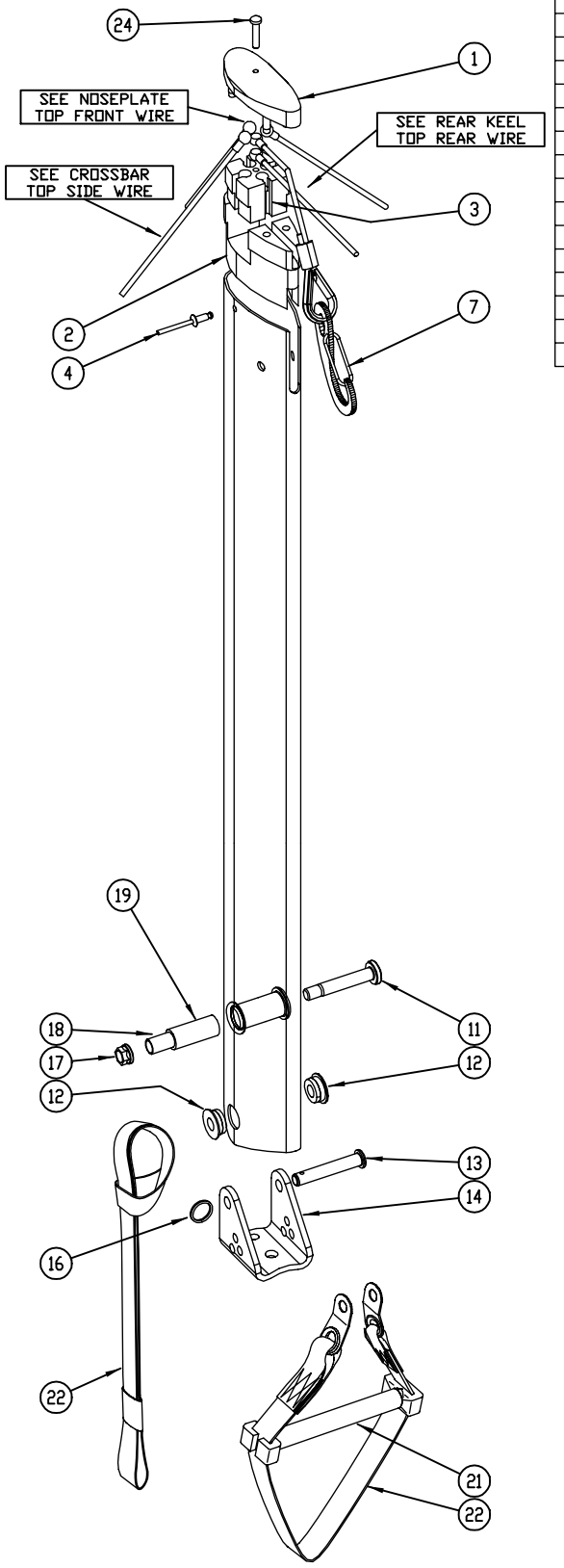


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TITLE: Ultra Sport Noseplate

PART NO:	DWG ID:	DOCUMENT ID:	REVISED:	DRAWN:	SCALE:
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T.U.S. .X ± .05
.XX ± .015
.XXX ± .003
.XXXX ± .0005
ANGLES ± 1/2°



ID	PART NO	DESCRIPTION	QNT
1	15J-1501	CAP AT KINGPOST TOP POLYCARB	1
2	15J-1502	TOP AT KINGPOST POLYCARB	1
3	20G-2323	KINGPOST TOP INSERT AT ALUM	1
4	10R-0342	RIVET AL 1/8 * .25	2
11	10C-5191	BOLT NAS 623-4-19	1
12	10T-8010	BUSH MACHINED KP BASE KP HANG	2
13	10G-2410	CLEVIS PIN MS20392-3C41	1
14	20A-1214	BRACKET, KP BASE KP HANG	1
16	10P-1100	SAFETY RING AN 9491 SMALL	1
17	10N-1740	CLINCH NUT 1/4 MS21042-4	1
18	10T-1121	SPACER AL .313 * .028 * 1.075	1
19	10T-5132	BUSH FGLASS .414 * .337 * 1.0	1
20	40K-1311	KNGPST STRM LF VG KP HANG TUBE	1
21	20G-2812	SPREADER BAR XC KINGPOST HANG	1
22	45J-1401	HANG LOOP SET - KINGPOST STK	1
24	10M-1361	SCREW 6/32 FLSTR MACH HEAD SS	1

T.U.S. .X ± .05
.XX ± .015
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ANGLES ± 1/2°

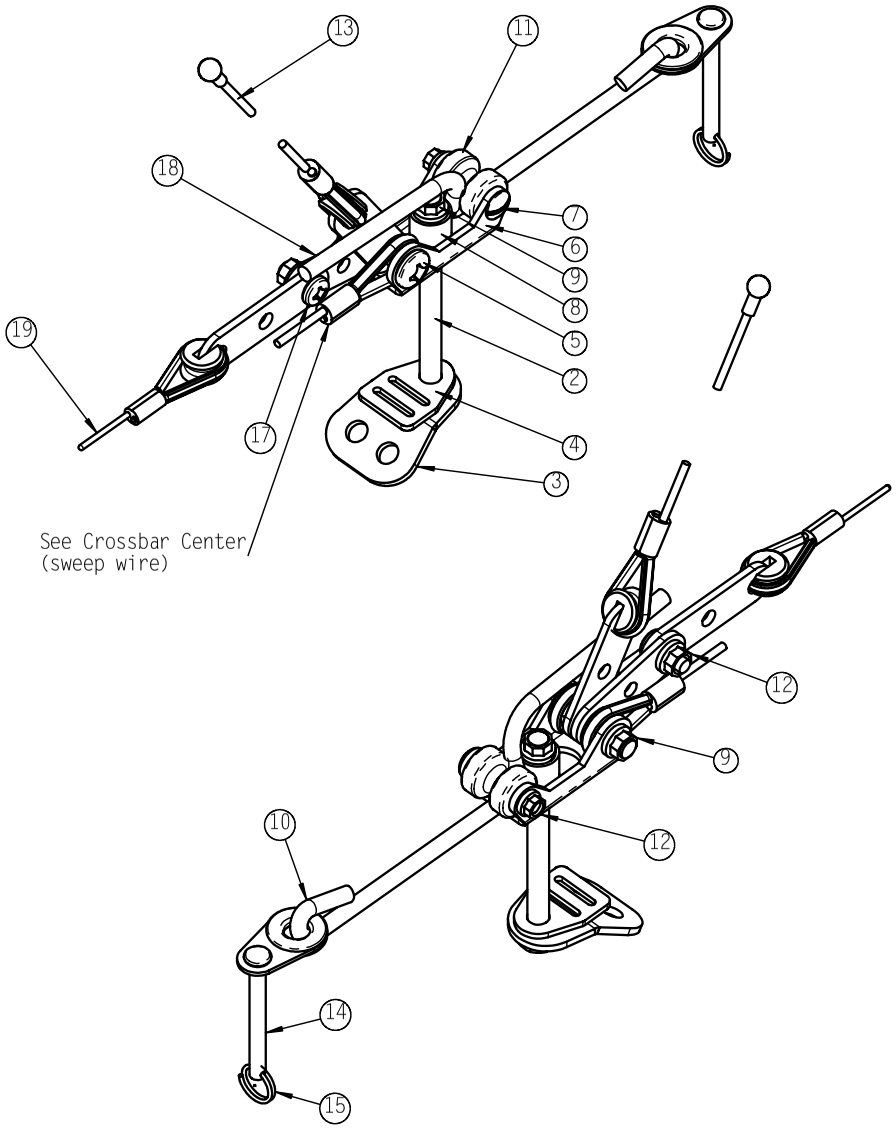
TITLE: Ultra Sport Kingpost

PART NO: NA
DWG ID: 82E05.DWG
DOCUMENT ID: 82E05
REVISED:
DRAWN: 12-01-96 sp
SCALE: NA

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Ultra Sport 147 Kingpost Assembly

Ultra Sport 135 and 166 Rear Keel



ID	PART NO	DESCRIPTION	QNT
1	15A-1007	FRICTION CAP 7/8	1
2	10A-2271	BOLT AN4-27A	1
3	40P-3301	WIRE SET BOTTOM REAR BALL SWDG	1
4	20E-2321	TANG 1 HOLE 2 SLOT 5/8 WEBBING	1
5	10C-5121	BOLT NAS 623-4-12	1
6	20A-1601	BRACKET, KEYHOLE TYPE LAYFLAT	1
7	10B-1161	BOLT AN23-16A	1
8	20G-2901	COLLAR KEYHOLE TANG BOLT	1
9	10N-1740	CLINCH NUT 1/4 MS21042-4	2
10	45K-1502	XBAR PULLBACK ROPE - XC	1
11	15K-1001	PULLEY DELRIN KEYHOLE BRACKET	1
12	10N-1730	CLINCH NUT 3/16 MS20142-3	1
13	40P-2401	WIRE TOP REAR BALL SWEDG 3/32	1
14	10G-1570	CLEVIS PIN MS20392-2C57	1
15	10P-1100	SAFETY RING AN 9491 SMALL	1
16	15B-1612	ENDCAP 1 3/4 .049	1
17	10D-1060	BOLT NAS 603-6	1
18	20E-2305	TANG 3 HOLE FOLDNG BASE CENTER	1
19	40P-5007	WIRE VG COMPENSATOR LOWER XC	1

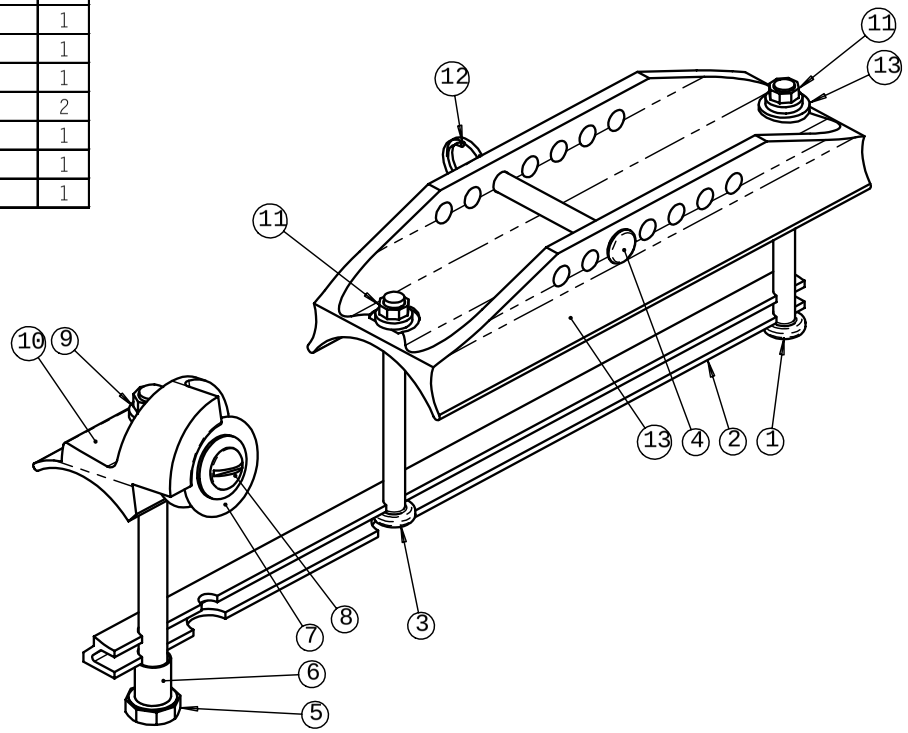
WILLS WING
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TITLE: **Ultra Sport 135 and 166 Rear Keel**

Document ID:	DWG ID:	DATE:	REVISED:	BY:
84E01.0	US Rear Keel.DRW	10-30-97	-	Pearson

Ultra Sport 135 and 166 Middle Keel

ID	PART NO	DESCRIPTION	QNT
1	10C-4341	BOLT NAS 623-3-34	1
2	20G-2103	TRACK LAYFLAT CBAR APEX SHORT2	1
3	10C-4301	BOLT NAS 623-3-30	1
4	10G-1510	CLEVIS PIN MS20392-2C51	1
5	10A-2271	BOLT AN4-27A	1
6	10T-3100	SPACER SS .313 * .028 * .390	1
7	20P-1230	PULLEY HARKN SHEAVE TOP LEG VG	1
8	10B-1101	BOLT AN23-10A	1
9	10N-1740	CLINCH NUT 1/4 MS21042-4	1
10	20G-1510	BRACKET VG PULLEY KEEL MOUNT	1
11	10N-1730	CLINCH NUT 3/16 MS20142-3	2
12	10P-1100	SAFETY RING AN 9491 SMALL	1
13	10U-1130	WASHER STEEL AN960-10	1
14	20G-1312	CG BRACKET KP HANG 95	1



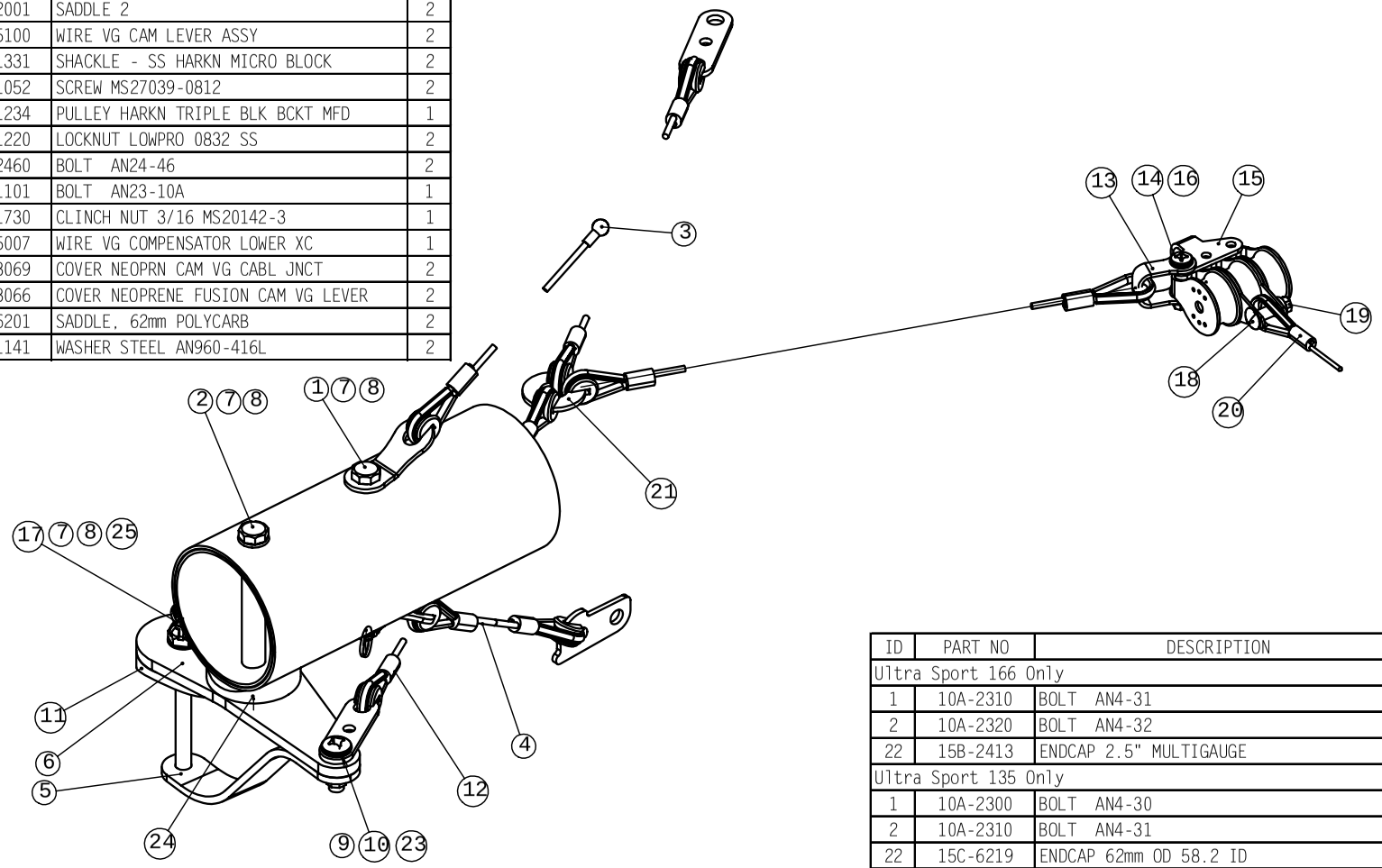
WILLS WING
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TITLE: **Ultra Sport 135 and 166 Middle Keel**

Document ID:	DWG ID:	DATE:	REVISED:	BY:
84E02.0	US Center Keel.DRW	06-29-98	-	Pearson

Ultra Sport 135 and 166 Cam VG

Common Parts Ultra Sport 135 and 166			
ID	PART NO	DESCRIPTION	QNT
3	40P-2202	WIRE TOP SIDE BALL SWEDGE 3/32	2
4	40P-3104	WIRE BOTTOM SIDE 1/8 AT STYLE	2
5	20C-1755	XBAR PLATE SUPPRT STRP CAM VG 52	2
6	20C-1751	XBAR PLATE CAM VG LEVER	6
7	10P-1100	SAFETY RING AN 9491 SMALL	6
8	10N-1340	CASTLENUT 1/4 AN310-4	6
9	10N-1740	CLINCH NUT 1/4 MS21042-4	2
10	10C-5071	BOLT NAS 623-4-7	2
11	15D-2001	SADDLE 2	2
12	40P-5100	WIRE VG CAM LEVER ASSY	2
13	20P-1331	SHACKLE - SS HARKN MICRO BLOCK	2
14	10L-1052	SCREW MS27039-0812	2
15	20P-1234	PULLEY HARKN TRIPLE BLK BCKT MFD	1
16	10N-1220	LOCKNUT LOWPRO 0832 SS	2
17	10B-2460	BOLT AN24-46	2
18	10B-1101	BOLT AN23-10A	1
19	10N-1730	CLINCH NUT 3/16 MS20142-3	1
20	40P-5007	WIRE VG COMPENSATOR LOWER XC	1
21	45G-3069	COVER NEOPRN CAM VG CABL JNCT	2
23	45G-3066	COVER NEOPRENE FUSION CAM VG LEVER	2
24	15F-6201	SADDLE, 62mm POLYCARB	2
25	10U-1141	WASHER STEEL AN960-416L	2



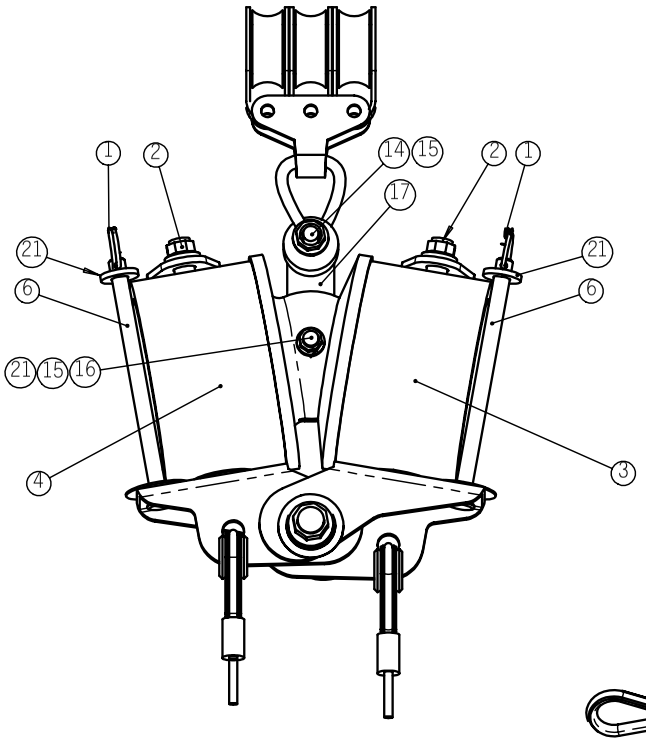
ID	PART NO	DESCRIPTION	QNT
Ultra Sport 166 Only			
1	10A-2310	BOLT AN4-31	2
2	10A-2320	BOLT AN4-32	2
22	15B-2413	ENDCAP 2.5" MULTIGAUGE	2
Ultra Sport 135 Only			
1	10A-2300	BOLT AN4-30	2
2	10A-2310	BOLT AN4-31	2
22	15C-6219	ENDCAP 62mm OD 58.2 ID	2

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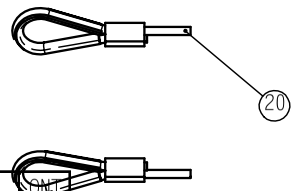
TITLE: **Ultra Sport 135 and 166 Cam VG**

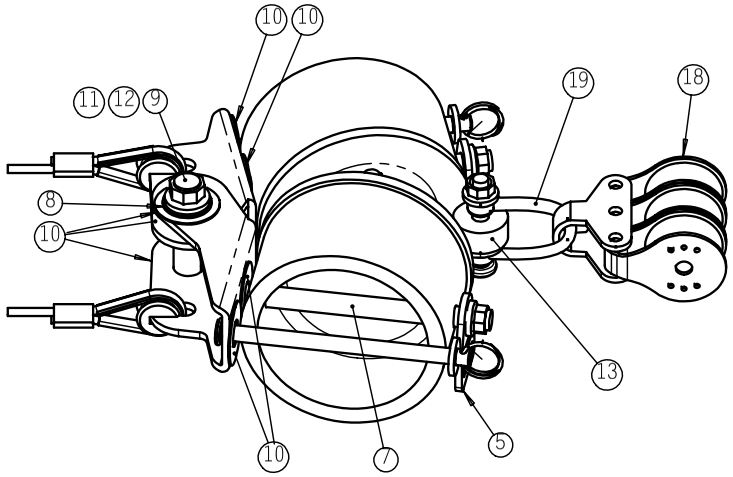
Document ID:	DWG ID:	DATE:	REVISED:	BY:
84E03.1	US66 Cam VG.DRW	06-29-98	-	Pearson

Ultra Sport 135 and 166 Crossbar Center



ID	PART NO	DESCRIPTION	QNT
1	10P-1100	SAFETY RING AN 9491 SMALL	2
2	10N-1740	CLINCH NUT 1/4 MS21042-4	2
5	45K-1315	XBAR STRAP HOLD DOWN US166	1
8	10U-1151	WASHER STEEL AN960-516L	1
9	10N-1750	CLINCH NUT 5/16 MS21042-5	1
10	10U-5125	WASHER NYLON .75 * .316 * .020	9
11	10C-6171	BOLT NAS 623-5-17	1
12	15A-1103	NUT CAP SHALLOW	1
13	10T-5101	SPACER NY .75 * .125 * .310	1
14	10C-4121	BOLT NAS 623-3-12	1
15	10N-1730	CLINCH NUT 3/16 MS20142-3	2
16	10A-1151	BOLT AN3-15A	1
17	20E-2305	TANG 3 HOLE FOLDNG BASE CENTER	1
18	20P-1232	PULLEY HARKN TRIPLE BLOCK	1
19	20P-1341	SHACKLE - SS FORGED HALF TWIST	1
20	40P-4204	WIRE XBAR SWEEP CNTR HINGE SET	1
21	10U-1130	WASHER STEEL AN960-10	3





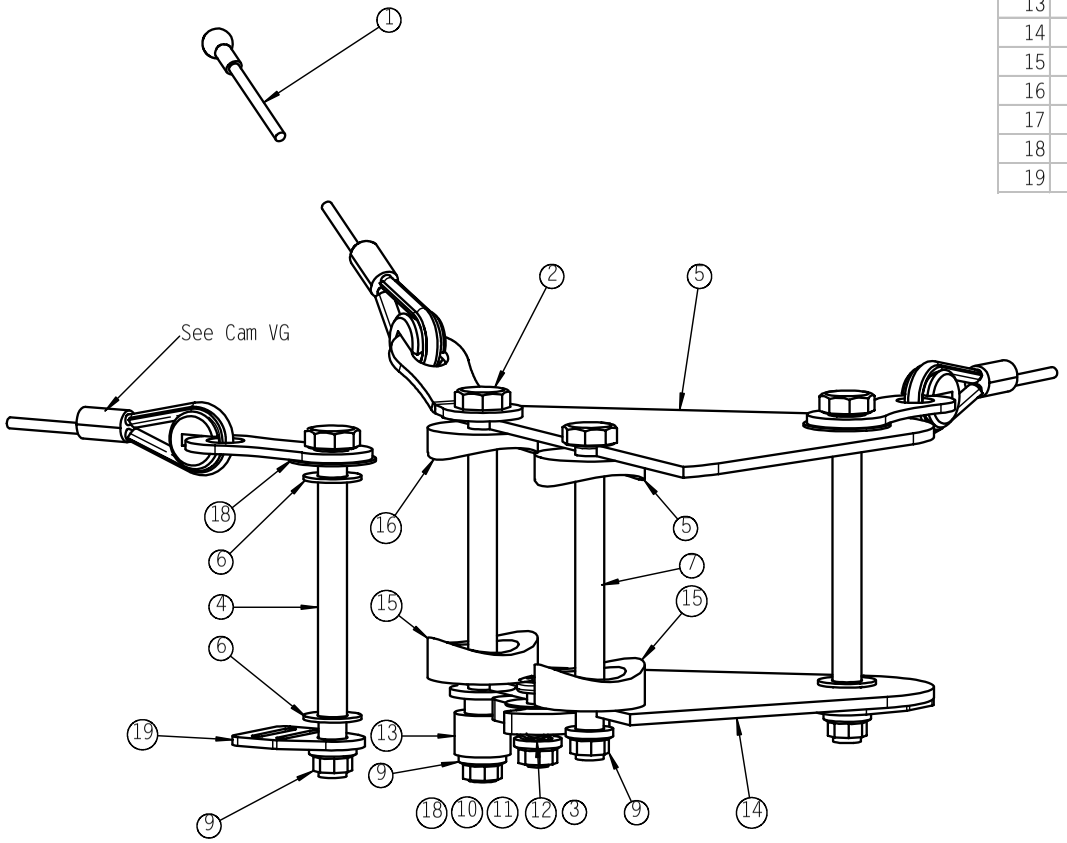
ID	PART NO	DESCRIPTION	QNT
Ultra Sport 135 only			
3	15J-2111	SOCKET XBAR CNTR BALL JNT 60B	1
4	15J-2121	BALL XBAR CNTR BALL JNT 60B SLOTTED	1
6	10G-1830	CLEVIS PIN MS20392-2C83	2
7	10A-2271	BOLT AN4-27A	2
Ultra Sport 166 only			
3	15J-2118	SOCKET XBAR CNTR BALL JNT 2.5	1
4	15J-2128	BALL XBAR CNTR BALL JNT 2.5 SLOTTED	1
6	10G-1830	CLEVIS PIN MS20392-2C83	2
7	10A-2301	BOLT AN4-30A	2

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TITLE: **Ultra Sport 135 and 166 Crossbar Center**

Document ID:	DWG ID:	DATE:	REVISED:	BY:
84E04.1	US Crossbar Center.DRW	06-29-98	-	Pearson

ID	PART NO	DESCRIPTION	QNT
1	40P-2301	WIRE TOP FRONT BALL SWEDG 3/32	1
2	10A-2321	BOLT AN4-32A	1
3	10N-1730	CLINCH NUT 3/16 MS20142-3	1
4	10A-2271	BOLT AN4-27A	2
5	20C-1621	NOSEPLATE RAMAIR TOP EXTENDED	1
6	10U-1141	WASHER STEEL AN960-416L	4
7	10A-2251	BOLT AN4-25A	1
8	10U-1140	WASHER STEEL AN960-416	0
9	10N-1740	CLINCH NUT 1/4 MS21042-4	4
10	10U-5093	WASHER NYLON .560 *.192 *.015	1
11	20C-1501	SAFETY ALUM KEYHOLE ANCHOR	1
12	10U-8010	WASHER WAVE KEYHOLE ANCHOR	1
13	20G-2901	COLLAR KEYHOLE TANG BOLT	1
14	20C-1611	NOSEPLATE HARRIER THRU CURRENT	1
15	15F-1404	STAND-OFF 1/4	2
16	15F-1602	STAND-OFF 1/8	2
17	40P-3201	WIRE SET BOTTM FRONT BALL SWDG	1
18	10U-5125	WASHER NYLON .75 * .316 * .020	2
19	20E-2321	TANG 1 HOLE 2 SLOT 5/8 WEBBING	2

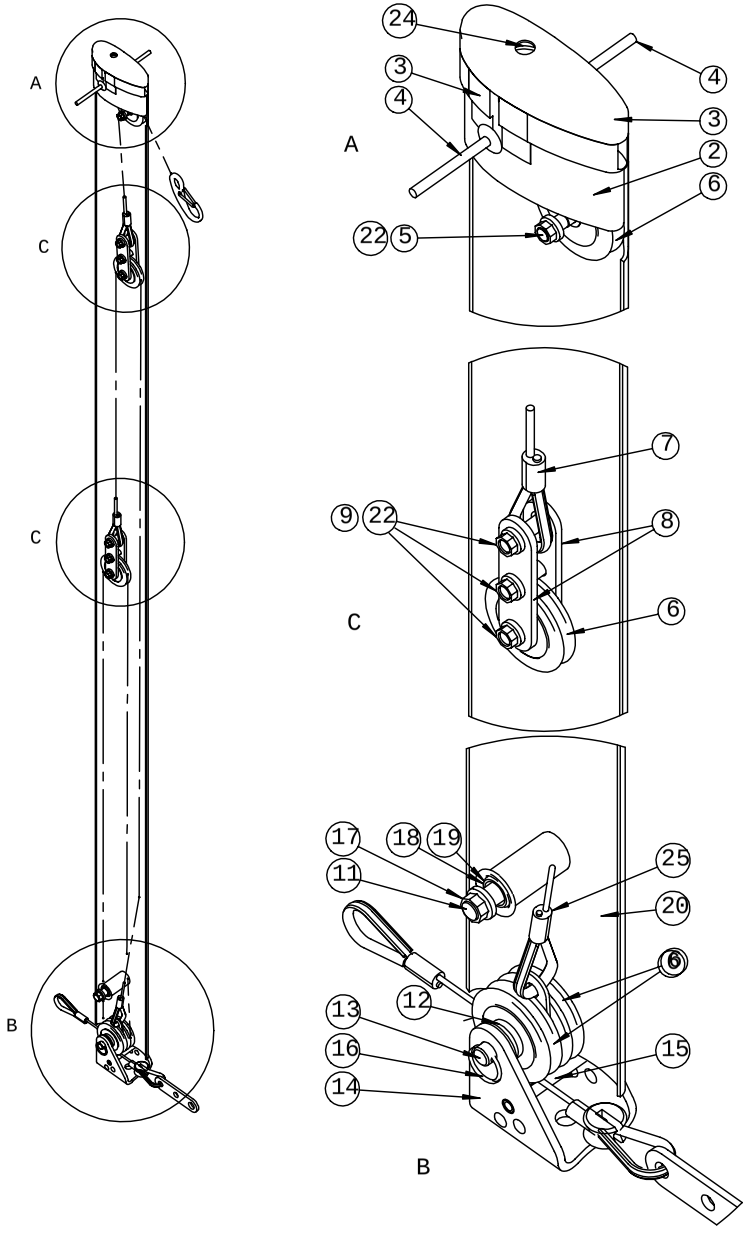


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TITLE: **Ultra Sport 135 and 166 Noseplate**

Document ID:	DWG ID:	DATE:	REVISED:	BY:
84E05.0	US66 Noseplate.DRW	10-30-97	-	Pearson

Ultra Sport 135 and 166 Kingpost



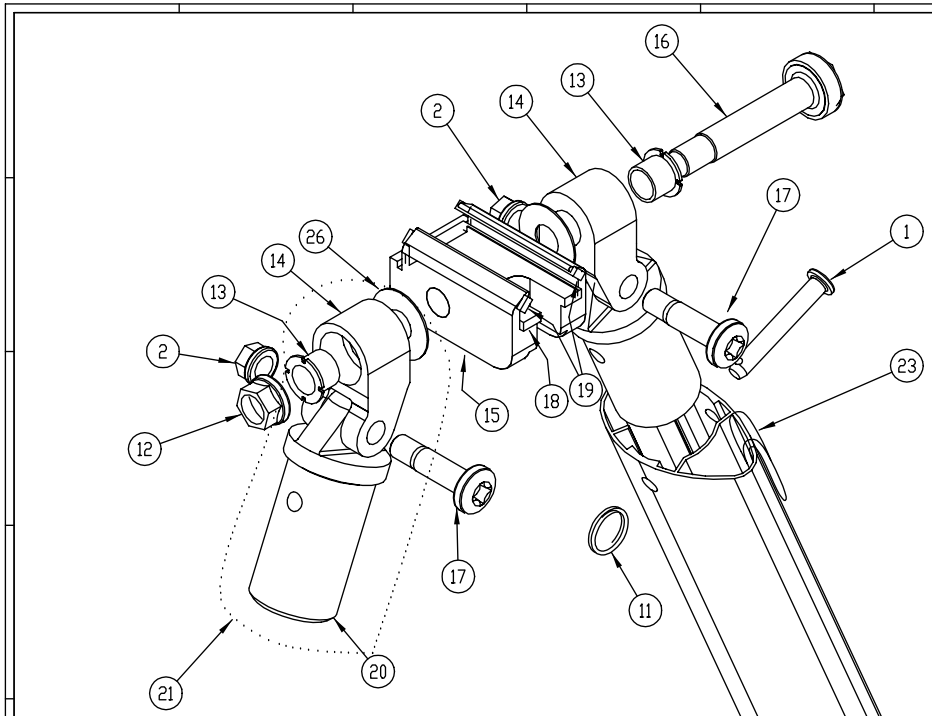
ID	PART NO	DESCRIPTION	QNT
1	15J-1501	CAP AT KINGPOST TOP POLYCARB	1
2	15J-1502	TOP AT KINGPOST POLYCARB	1
3	20G-2323	KINGPOST TOP INSERT AT ALUM	1
4	10R-0342	RIVET AL 1/8 * .25	2
5	10B-1161	BOLT AN23-16A	1
6	15K-1011	PULLEY DELRIN AN210-1A REPLACE	5
	10T-4111	BUSH SS .312 * .058 * .295	5
7	40P-5002	WIRE VG COMPENSATOR UPPER	1
8	20E-2304	TANG 3 HOLE VG 2" LONG	4
9	10B-1101	BOLT AN23-10A	6
10	40P-5007	WIRE VG COMPENSATOR LOWER XC	1
11	10C-5191	BOLT NAS 623-4-19	1
12	10T-8010	BUSH MACHINED KP BASE KP HANG	2
13	10G-2410	CLEVIS PIN MS20392-3C41	1
14	20A-1214	BRACKET, KP BASE KP HANG	1
15	10K-4021	PIN COIL SPRING .187 * 1.250	1
16	10P-1100	SAFETY RING AN 9491 SMALL	1
17	10N-1740	CLINCH NUT 1/4 MS21042-4	1
18	10T-1121	SPACER AL .313 * .028 * 1.075	1
19	10T-5132	BUSH FGLASS .414 * .337 * 1.0	1
20	40K-1311	KNGPST STRM LF VG KP HANG TUBE	1
21	10M-1361	SCREW 6/32 FLSTR MACH HEAD SS	1
22	10N-1730	CLINCH NUT 3/16 MS20142-3	7
23	40P-5009	WIRE VG COMPENSATOR MIDDLE	1

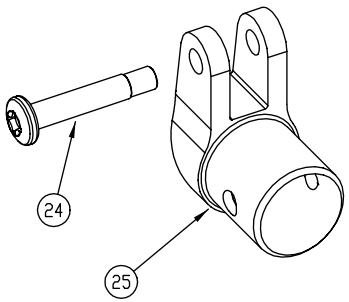
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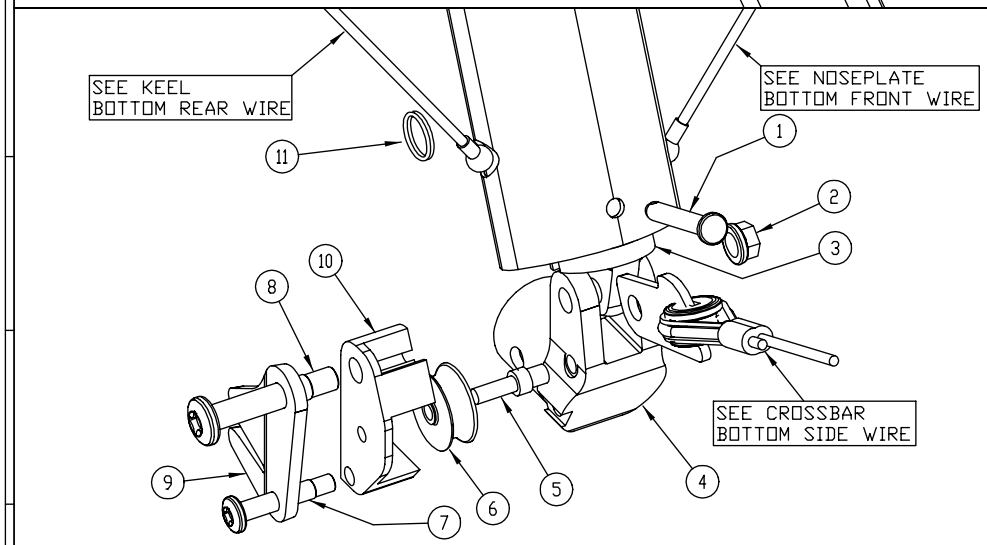
TITLE: **Ultra Sport 166 Kingpost**

Document ID:	DWG ID:	DATE:	REVISED:	BY:
84E06.0	US66 Kingpost.DRW	10-30-97	-	Pearson

VG Control Bar Assembly







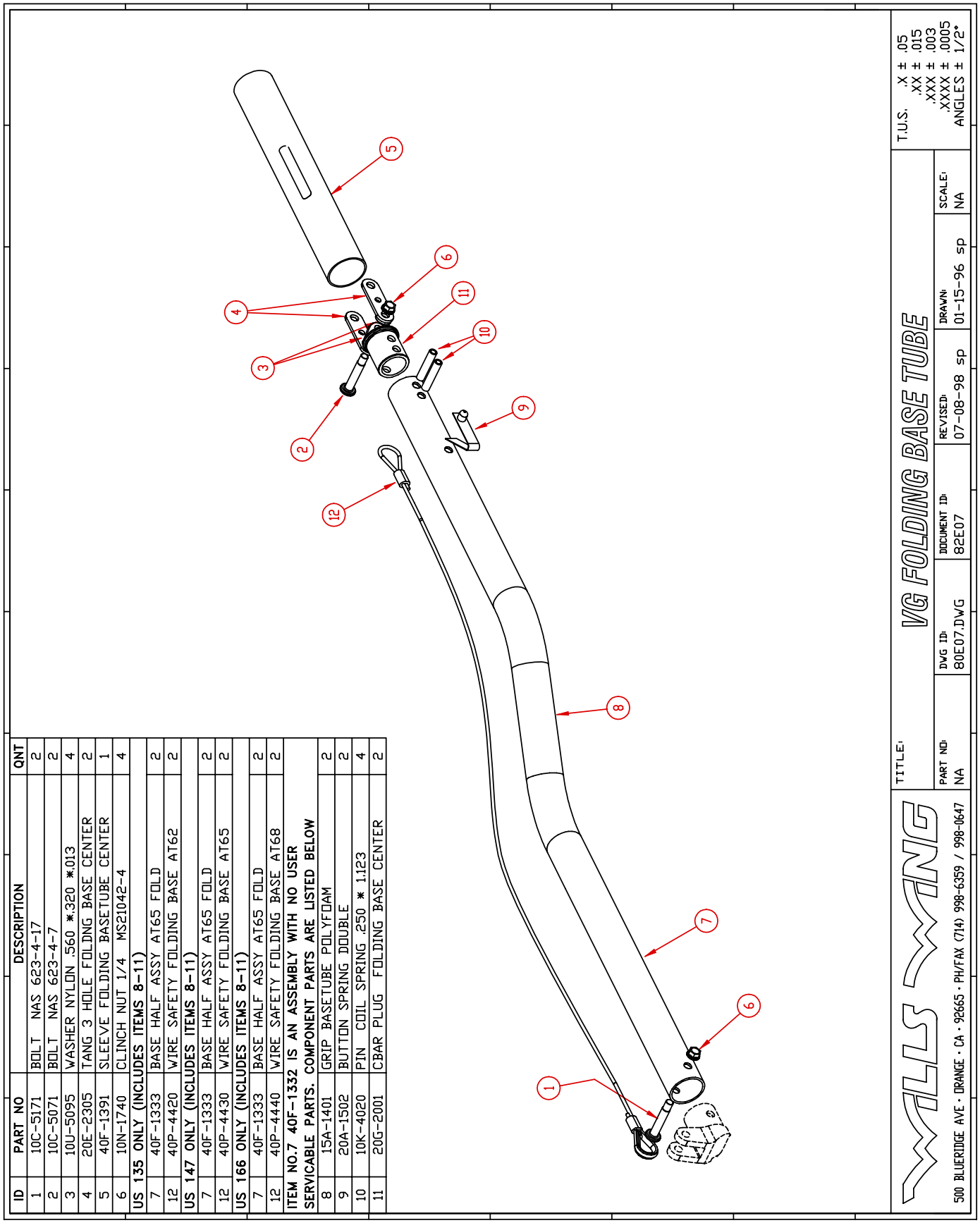
ID	PART NO	DESCRIPTION	QNT
1	10G-1330	CLEVIS PIN MS20392-2C33	4
2	10N-1740	CLINCH NUT 1/4 MS21042-4	4
3	20G-1423	REPLACED BY 20G-1424	2
4	20G-1802	CBAR BRACKET AT BASE END VG	1
5	10K-4040	PIN VG PULLEY SS MACHINED	1
6	20P-1220	PULLEY ALUM MACH CBAR BASE VG	1
7	10D-1161	BOLT NAS 603-16P	1
8	10C-5241	BOLT NAS 623-4-24	1
9	20C-1801	JAMCLEAT KNIFE V-CUT / ROPE VG	1
10	20G-1803	BRACKET BASE PULLEY ROPE VG	1
11	10P-1100	SAFETY RING AN 9491 SMALL	4
12	10N-1750	CLINCH NUT 5/16 MS21042-5	1
13	10T-5113	BUSH SPLIT HEADED AT CB SHORT	2
14	20G-1711	CBAR ELBOW AT TOP STREAM	2
15	20G-2203	SLIDER LAYFLAT CBAR APEX 3	1
16	10A-3201	BOLT AN5-20A GROUND & SLOTTED	1
17	10C-5111	BOLT NAS 623-4-11	2
18	15J-2003	GLIDE NOTCHED LAFLT APEX SLDR	1
19	15J-2002	GLIDE LAYFLAT APEX SLIDR SIDE	2
20	20G-1433	CBAR PLUG AT LEG TOP STR TOEIN	2
21	45G-3064	COVER NEOPRENE CB APEX RT VG	1
22	45G-3062	COVER NEOPRENE CBAR APEX LEFT	1
23	15A-1610	PROTECTOR VG ROPE - UHMW TAPE	1
24	10C-5121	BOLT NAS 623-4-12	1
25	20G-1801	CBAR BRACKET AT BASETUBE END	1
26	10U-5125	WASHER NYLON .75 * .316 * .020	2

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TITLE: VG CONTROL BAR

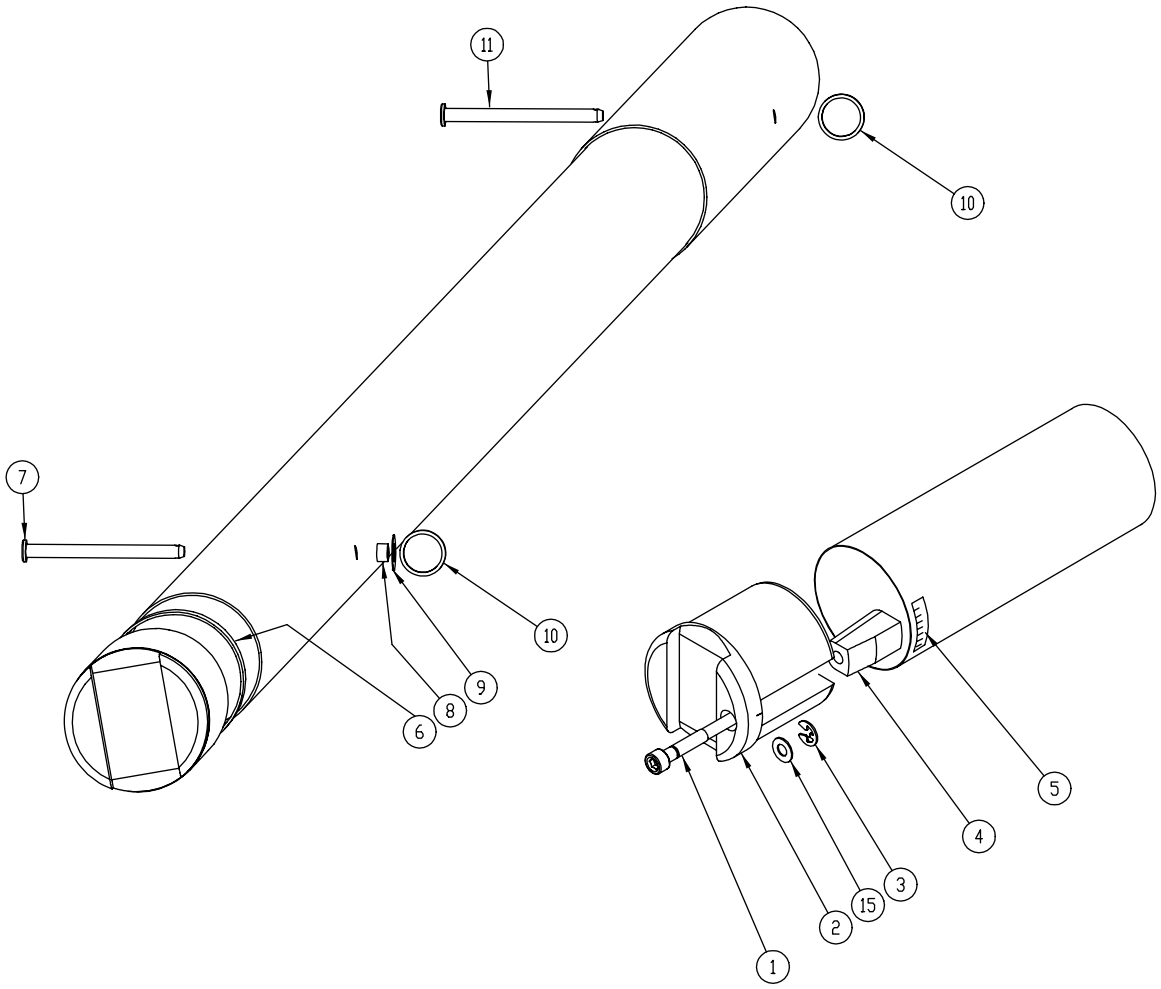
PART NO:	DWG ID:	DOCUMENT ID:	REVISED:	DRAWN:	SCALE:
NA	80E06.DWG	80E06	NA	01-15-96 sp	NA

T.U.S. .X ± .05
.XX ± .015
.XXX ± .003
.XXXX ± .0005
ANGLES ± 1/2°



VG Folding Basetube Assembly

ID	PART NO	DESCRIPTION	QNT
1	10K-2026	SCREW SOCKET CAP 10-32*1.75 SS	2
2	15J-1911	ENDCAP SAIL MOUNT ADJUSTABLE	2
3	10S-1101	C-CLIP SAIL ADJUSTER CAP SCREW	2
4	15J-1912	LOCKING SLIDE ADJUST ENDCAP	2
5	70G-4019	PLACARD - SAIL ADJUSTER ALIGN	2
6	40M-1321	SHIM KIT ALL 7075 MODELS 50mm	2
7	10G-2770	CLEVIS PIN MS20392-3C77	2
8	10T-1111	SPACER AL .375 * .035 * .375	2
9	10U-1400	WASHER MS 15795-210	2
10	10P-1100	SAFETY RING AN 9491 SMALL	4
11	10G-1650	CLEVIS PIN MS20392-2C65	2
15	10U-1130	WASHER STEEL AN960-10	2



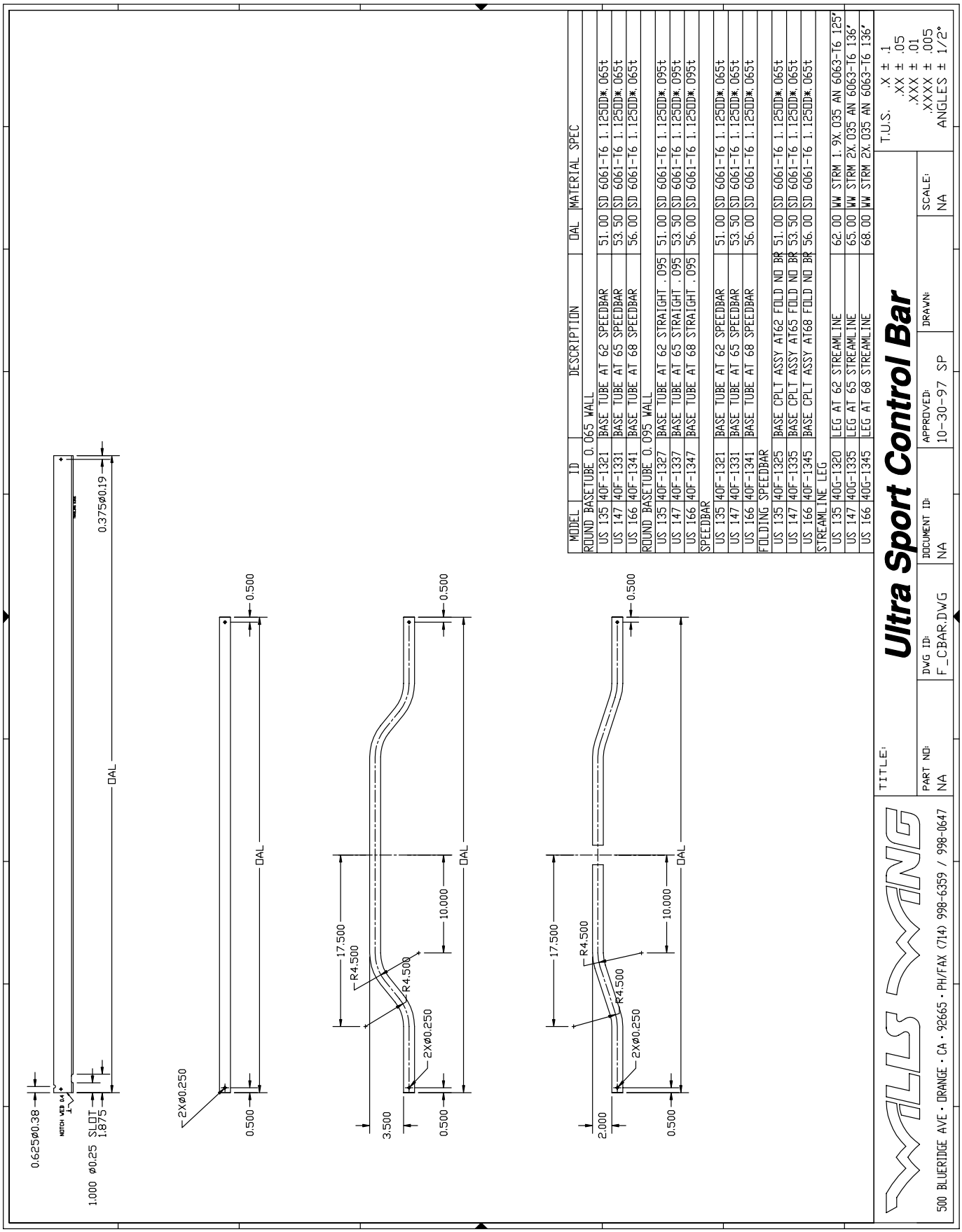
T.U.S. .X ± .05
.XX ± .015
.XXX ± .003
.XXXX ± .0005
ANGLES ± 1/2°

TITLE: Ultra Sport Rear Leading Edge

PART NO: NA
DWG ID: 82E09.DWG
DOCUMENT ID: 82E09
REVISED:
DRAWN: 12-01-96 sp
SCALE: NA

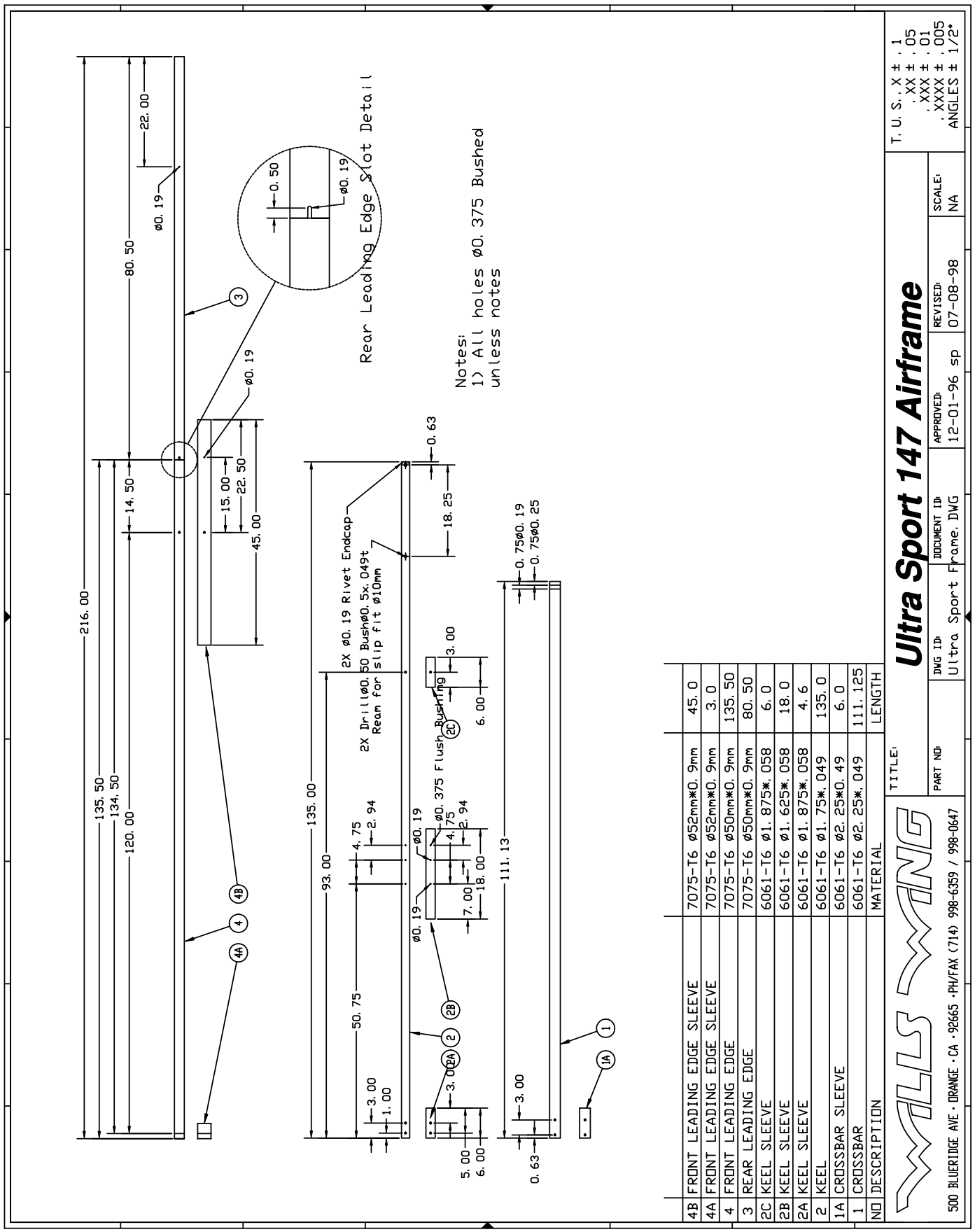
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Ultra Sport Rear Leading Edge Assembly

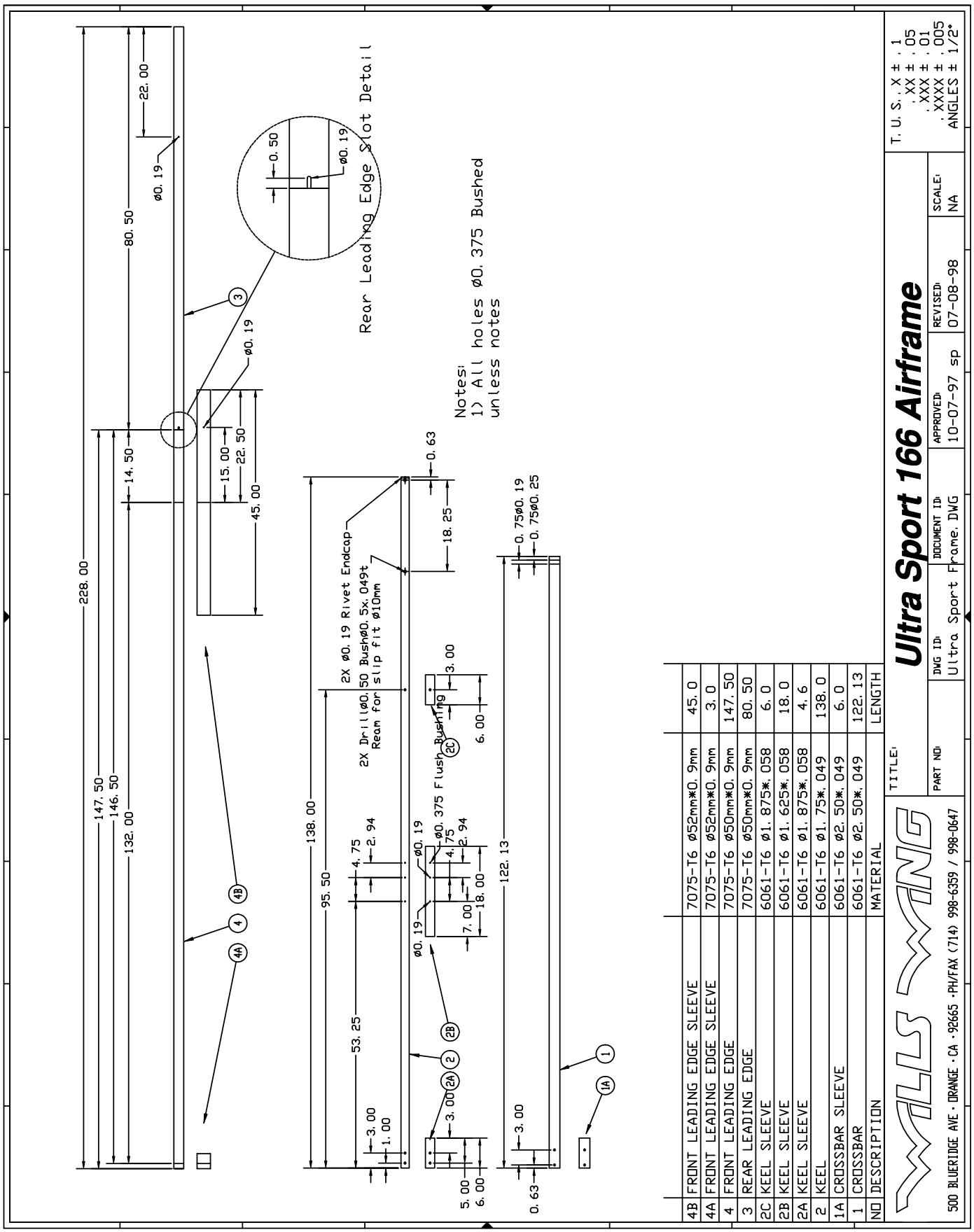


MODEL	ID	DESCRIPTION	OAL	MATERIAL SPEC
ROUND BASETUBE 0.065 WALL				
US 135	40F-1321	BASE TUBE AT 62 SPEEDBAR	51.00	SD 6061-T6 1.125OD×.065t
US 147	40F-1331	BASE TUBE AT 65 SPEEDBAR	53.50	SD 6061-T6 1.125OD×.065t
US 166	40F-1341	BASE TUBE AT 68 SPEEDBAR	56.00	SD 6061-T6 1.125OD×.065t
ROUND BASETUBE 0.095 WALL				
US 135	40F-1327	BASE TUBE AT 62 STRAIGHT .095	51.00	SD 6061-T6 1.125OD×.095t
US 147	40F-1337	BASE TUBE AT 65 STRAIGHT .095	53.50	SD 6061-T6 1.125OD×.095t
US 166	40F-1347	BASE TUBE AT 68 STRAIGHT .095	56.00	SD 6061-T6 1.125OD×.095t
SPEEDBAR				
US 135	40F-1321	BASE TUBE AT 62 SPEEDBAR	51.00	SD 6061-T6 1.125OD×.065t
US 147	40F-1331	BASE TUBE AT 65 SPEEDBAR	53.50	SD 6061-T6 1.125OD×.065t
US 166	40F-1341	BASE TUBE AT 68 SPEEDBAR	56.00	SD 6061-T6 1.125OD×.065t
FOLDING SPEEDBAR				
US 135	40F-1325	BASE CPLT ASSY AT62 FOLD NO BR	51.00	SD 6061-T6 1.125OD×.065t
US 147	40F-1335	BASE CPLT ASSY AT65 FOLD NO BR	53.50	SD 6061-T6 1.125OD×.065t
US 166	40F-1345	BASE CPLT ASSY AT68 FOLD NO BR	56.00	SD 6061-T6 1.125OD×.065t
STREAMLINE LEG				
US 135	40G-1320	LEG AT 62 STREAMLINE	62.00	WW STRM 1.9X.035 AN 6063-T6 125"
US 147	40G-1335	LEG AT 65 STREAMLINE	65.00	WW STRM 2X.035 AN 6063-T6 136"
US 166	40G-1345	LEG AT 68 STREAMLINE	68.00	WW STRM 2X.035 AN 6063-T6 136"

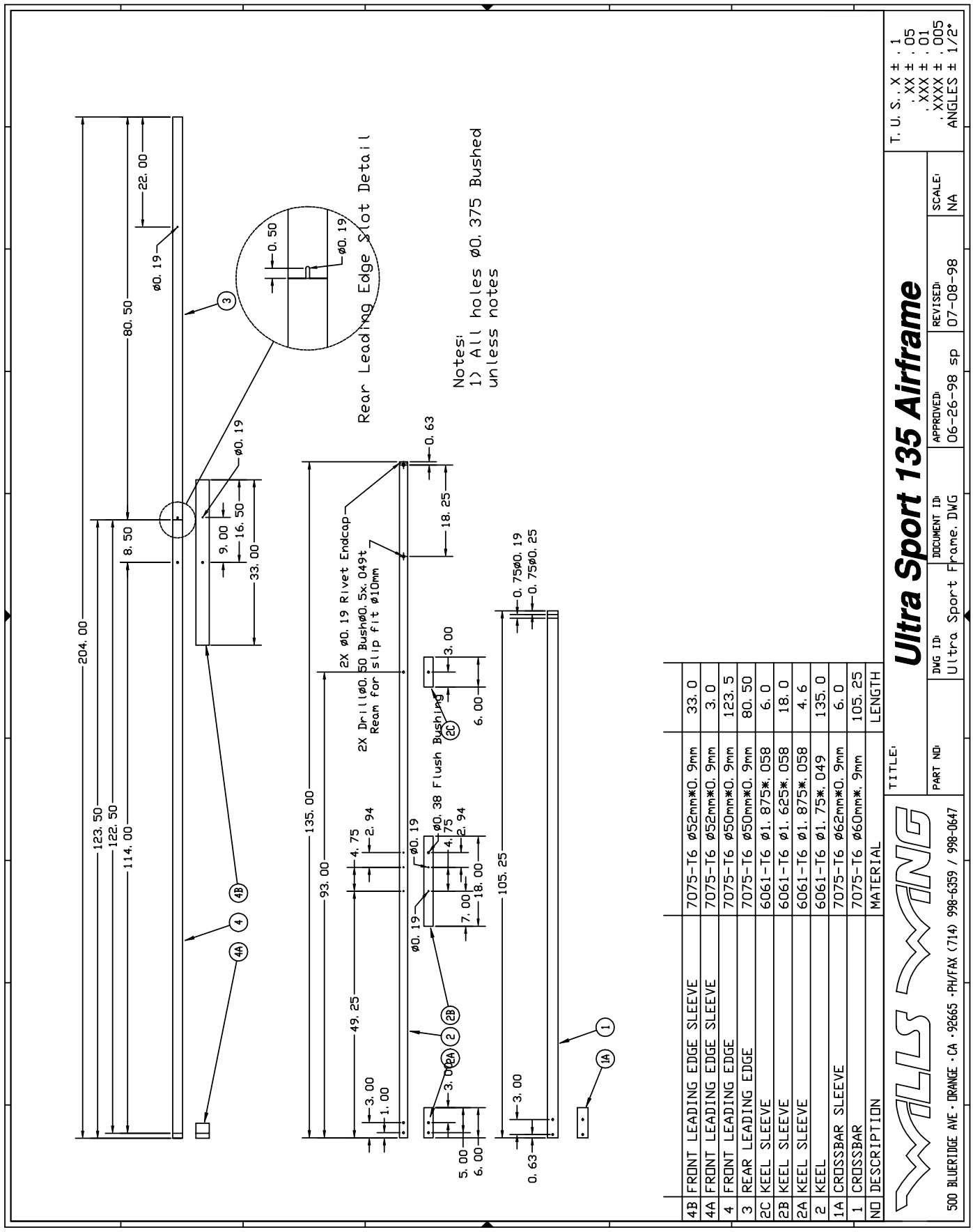
Ultra Sport Control Bar Specifications



Ultra Sport 147 Airframe

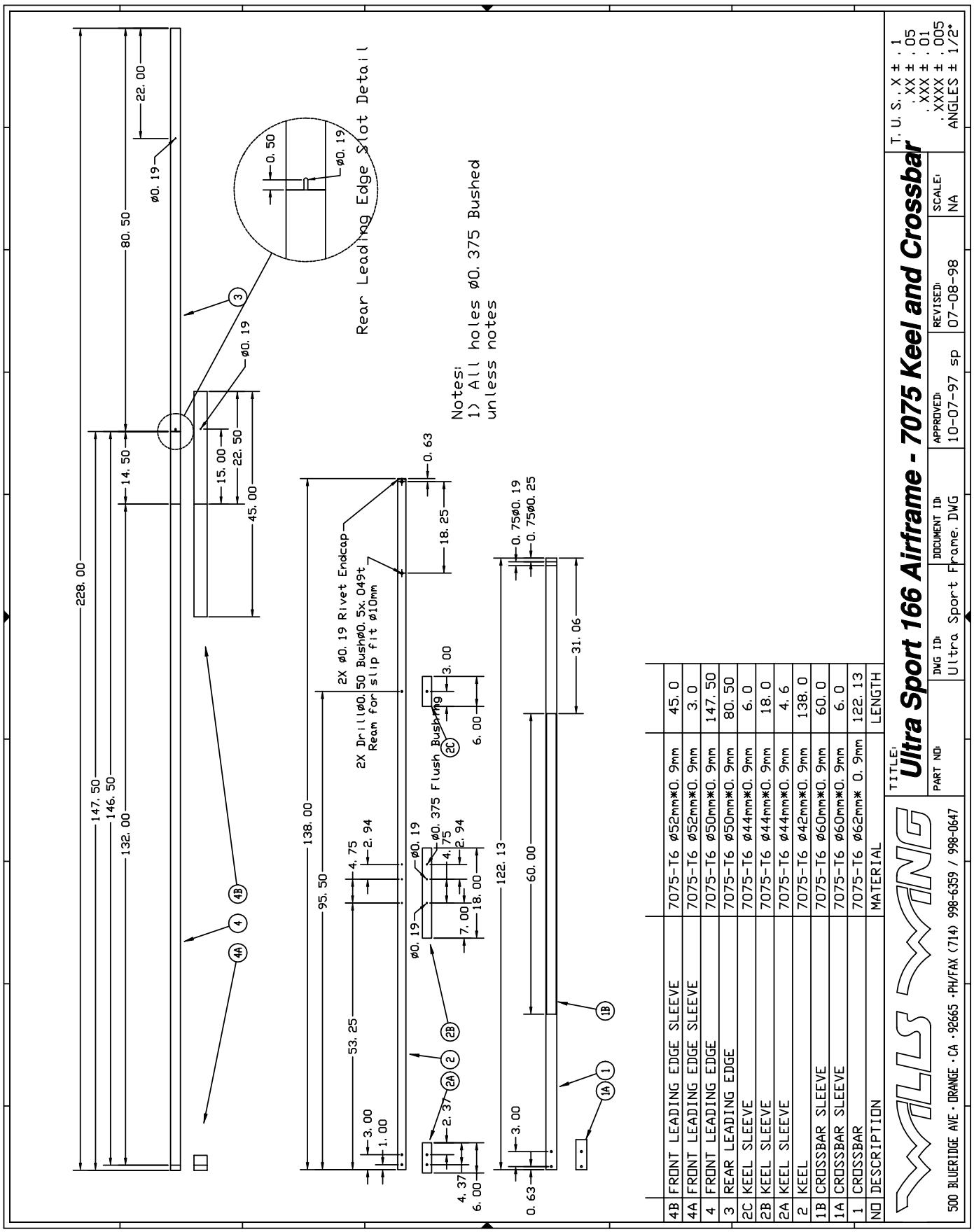


Ultra Sport 166 Airframe



ND	DESCRIPTION	MATERIAL	LENGTH
4B	FRONT LEADING EDGE SLEEVE	7075-T6 ø52mm*0.9mm	33.0
4A	FRONT LEADING EDGE SLEEVE	7075-T6 ø52mm*0.9mm	3.0
4	FRONT LEADING EDGE	7075-T6 ø50mm*0.9mm	123.5
3	REAR LEADING EDGE	7075-T6 ø50mm*0.9mm	80.50
2C	KEEL SLEEVE	6061-T6 ø1.875*.058	6.0
2B	KEEL SLEEVE	6061-T6 ø1.625*.058	18.0
2A	KEEL SLEEVE	6061-T6 ø1.875*.058	4.6
2	KEEL	6061-T6 ø1.75*.049	135.0
1A	CROSSBAR SLEEVE	7075-T6 ø62mm*0.9mm	6.0
1	CROSSBAR	7075-T6 ø60mm*.9mm	105.25

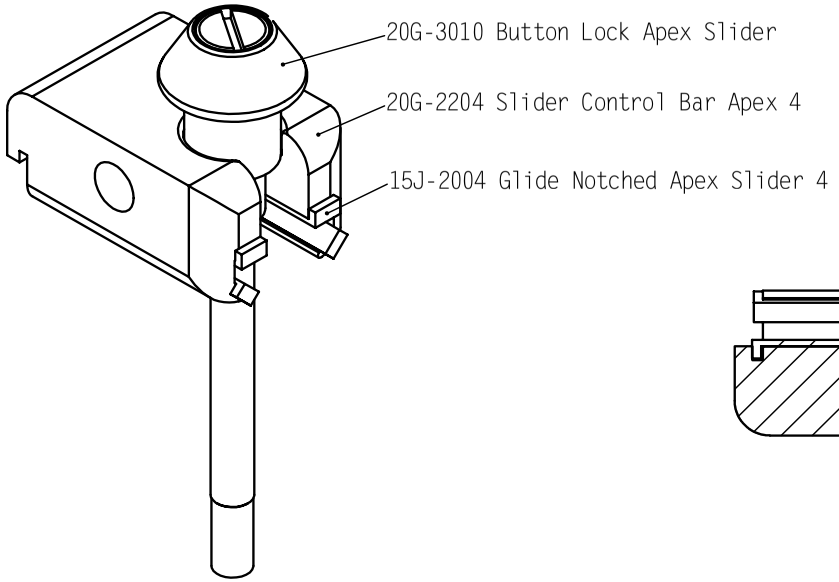
Ultra Sport 135 Airframe

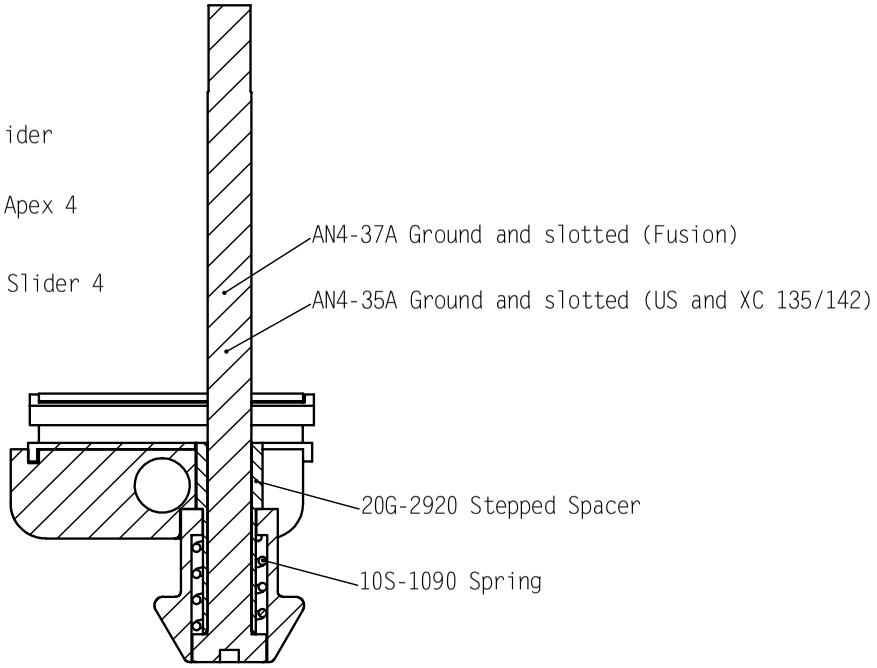


NO	DESCRIPTION	MATERIAL	LENGTH
4B	FRONT LEADING EDGE SLEEVE	7075-T6 ø52mm*0.9mm	45.0
4A	FRONT LEADING EDGE SLEEVE	7075-T6 ø52mm*0.9mm	3.0
4	FRONT LEADING EDGE	7075-T6 ø50mm*0.9mm	147.50
3	REAR LEADING EDGE	7075-T6 ø50mm*0.9mm	80.50
2C	KEEL SLEEVE	7075-T6 ø44mm*0.9mm	6.0
2B	KEEL SLEEVE	7075-T6 ø44mm*0.9mm	18.0
2A	KEEL SLEEVE	7075-T6 ø44mm*0.9mm	4.6
2	KEEL	7075-T6 ø42mm*0.9mm	138.0
1B	CROSSBAR SLEEVE	7075-T6 ø60mm*0.9mm	60.0
1A	CROSSBAR SLEEVE	7075-T6 ø60mm*0.9mm	6.0
1	CROSSBAR	7075-T6 ø62mm* 0.9mm	122.13

Ultra Sport 166 Euro Airframe

Note:
Replaces Item 5 and Item 6 Drawings 82E01 and 84E02
and Items 15, 18 Drawing 80E06





A-A

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TITLE: **Button Lock Apex Slider Assembly**

Document ID:	DWG ID:	DATE:	REVISED:	BY:
na	na	06-29-98	-	Pearson