Steps for W17, W14,W07, Wing Assembly — Eric Witherspoon
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Please read this whole set of steps before proceeding. It's ok if you haven't riveted the spar yet, because these steps start with the spar all ready to go, but not riveted. You may not agree with how I got it done and if so, your idea of an acceptable method may lead to the steps here either being unnecessary or used in a different order. Also, I may have a tip or trick further down which you could have used in the steps above. I tried to bring them to the front, but I'm not a writer.

Steps for W07, W14, W17:

1. **Section 1**: Prerequisites: Level of W08 spar completion - main spar is completed but not riveted. Prior to riveting the main spar, cleco the forward and aft ribs and rib spacers to it in order to drill these to final hole size. Wing assembly below starts with all of the ribs able to cleco to the main spar at final hole size. Also optional to do the main box steps below (up to Section 3) prior to riveting the main spar to avoid having to work with the spar in its curved shape (spar becomes curved forward/aft during riveting).
2. Level of aft spar completion: Aft spar is completed and riveted per print.
3. Level of ribs completion: All ribs are complete, including installation of the gussets on the inboard ribs – except for the root ribs. Root ribs do not have the gussets installed.
4. **Section 2**: Initial main box preparation: Working the main box of the wing - the section from the main spar aft to the aft spar. Cleco the aft ribs and spacers to the main spar. Leave out the root ribs at this time.
5. Cleco the aft spar to the aft ribs. Forward ribs are not clecoed in place in this section.
6. Level the wing framework on the sawhorses by blocking up the aft

spar until level is indicated between the forward and aft spars. The level will need to be blocked above the spar at the inboard end because it will sit on the aft edge of the spar cap and not on the peak between the two webs without blocking. Set the level on small blocks of wood of equal thickness – one block edge at the forward edge of the aft spar, the other block edge at the center peak of the main spar extrusion. Block up the aft spar off the sawhorse until the overall assembly is level. This is a gross leveling, not the final or exact leveling, because the wing can still substantially twist with one skin installed (or even with both aft skins installed but not clecoed to the main spar). Not sure how leveling the sawhorses and setting the wing down on them works – because the spar at the root end of the wing will lift the inboard forward end of the wing higher than at the outboard sawhorse. Blocking up the aft edge to a level check on top is all I could come up with.

7. Root rib drilling: Draw a line ¼" in from the aft edge of the forward root rib (inboard side), and ¼" in from the forward and aft edges of the aft root rib (also on the inboard side).

a. Clamp the root ribs into position on the outboard side of the attach brackets, using the lines drawn on for forward/aft positioning. To get the forward root rib positioned up and down, cleco 3 or 4 of the inner forward ribs into position, placing a straightedge across them to locate the forward root rib.

b. Drill the root ribs to the attach brackets from inboard side out. The flexibility of a 12" drill bit will help here. For the forward end of the aft root ribs, only the aft row of holes on the forward bracket is accessible this way. After drilling these and the aft bracket mount holes, move the rib to the inboard side of the bracket to get the rest of the holes on the forward bracket. See the prints for which side (inboard or outboard) is correct for the root ribs relative to the mount brackets.

8. Starting with the wing bottom side up, square up the ribs to the spar by sliding the aft spar laterally until the ribs are square to it and the forward spar. Using a carpenter's square along the main spar and a rib can help here.

9. Cleco the lower aft skin to the aft spar. May need to use cleco clamps for this to pull the main spar straight to the aft edge of the skin (if your spar is already riveted).

10. If necessary, slide the skin and aft spar laterally as required, to further square up the ribs so that the reference line drawn on the ribs shows through most of the skin holes.

Using spring clamps, spring clamp the forward edge of the lower aft skin to the main spar. This will temporarily lock down squareness in the inboard/outboard direction.

11. Drill the aft edge of the skin to the aft spar.
12. Drill the lower aft skin to the ribs. Use the guide line drawn on the ribs to get good edge distance for the rib flange holes. Ribs can be pushed side to side from below to center up the reference line if they are not absolutely straight. Once centered, the reference line can be kept in place by pressing down on the skin to the side of the rib on the side that the rib wants to slide off to.
13. Drill the lower aft skin to the main spar. The spar is about 3/16" thick at this point, and the anodizing makes the aluminum hard, so these holes take a while.
14. Turn the wing over to top side up.
15. Level it again – in preparation for adding the upper skin. Clecoing the upper skin to the aft and main spars establishes the twist (or lack thereof) in the wing. Don't add the upper skin now, there's more to do.
16. Complete the assembly of the #9 rib (added the 2 stiffeners plus the aileron bellcrank assembly) if not yet done.

a. For the stiffener to skin clips on the #9 rib, do not rivet these to the stiffener then drill them to the skin. The clips, if not set to the right height on the stiffener channels, can cause indentations or protrusions in the skin.
b. Place the stiffeners on the #9 rib, the #9 rib in the wing with just the lower aft skin in place, then hold the clips in place on the stiffener and mark where they fall.
c. Remove the stiffener and clip from the wing, then rivet the clips to the stiffener channels.
d. With the stiffener channels and clips back on the rib, square up the channels perpendicular to the rib line. I used a block of wood between the channels to keep them the right distance apart.
e. Using the 12" drill bit, drill the clip holes through the skin to pilot hole size.
f. Work a similar procedure on the clips to the upper skin after the upper skin is drilled in place and the lower skin is removed.

17. Drill the upper aft skin to the spars and ribs similar to the lower aft skin. I used the point of a small file to tweak the ribs left/right through the skin holes, and then once the rib was in the right place, I held pressure on the skin to keep the rib from moving. Hold pressure until the hole is drilled

(releasing pressure early can allow the rib to spring away from the hole causing the drill bit to break – how do I know this?)

18. Drill the flap and aileron hinges to the aft spar. It may help to do the aileron first by temporarily hanging it from the hinge to align it with the wing outboard end. Then similarly hang the flap from its hinge to establish the gap to the aileron.
19. Remove the aileron and flap, but leave the hinges.
20. Drill the wing box to final size, top and bottom EXCEPT for the row on the main spar and the inboard holes at the root rib where the root doubler sits (and on the LH wing, the 3 inner ribs outside of the root rib also stay at pilot hole size for later installation of the step doubler).
21. Disassemble the skins from the frame. Removing the lower skin first, go back and do step 16f. Without the forward ribs in place, one person can turn the wing over on the saw horses.
22. If not done yet, drill the hole for the tie down bolt in the lower aft skin. I drilled through the mount bracket to 3/8 size, then used the unibit to step it up to the size needed for the tie down bolt.
23. Cut the access hole in the lower skin for the aileron bellcrank, and drill the fastener holes for the access cover.
24. As a nice break to wing assembly, complete the spars per print W08 if not yet done (I had not riveted my spars until this point). Advantages of doing it here is you can debur the spar web at the rib attach holes, debur the caps at the web attach holes, and wing drilling so far has been done on a spar that is straight, though it doesn't take a whole lot of force to straighten it after riveting.
25. Debur the aft ribs all around, inside and out. They're done, so if you do alodine/primer stuff, you can do the aft ribs now.
26. Debur the aft spar all around, both sides. Aft spar is done, alodine away.
27. Debur the aileron and flap hinges. Done.
28. **Section 3**: Leading edge skin installation: Lay main spar aft side up on the sawhorses, cleco the aft rib spacers to the spar.
29. Cleco the aft ribs to the spar except for the root rib. Have the clecoes on the forward side of the spar.
30. Cleco the aft spar to the aft ribs.
31. Lay the wing down, bottom side up.
32. Debur all the lower aft skin holes that are final size.
33. Cleco the lower aft skin in place.
34. Turn wing over to top side up.
35. Cleco the forward ribs in place.

36. Level it on the sawhorses with a level between the aft and forward spars as described previously. This time, add small blocks just aft of the main spar to allow room to tuck the lower aft edge of the leading edge skin inside the lower aft skin. So the entire wing, forward and aft points where it is supported by the saw horses is up on blocks. The forward blocks are aft of the spar to allow for the forward skin tucking. Also position wing so forward spar is close to the edge of the sawhorses.
37. Debur all the upper aft skin holes that are final size.
38. Cleco the upper aft skin in place.
39. Mark the aft spar upper end for trimming (the square end of the aft spar doesn't quite follow the inboard curvature of the wing tip).
40. Add the forward skin – tuck it under the upper aft skin, over the spar. A guide line 3/8" from the edge of the skin is good to sight on for reference here.
41. Drill the upper forward skin to the main spar. Final size the holes to #30. Some have pilot-hole-sized the entire leading edge skin, then untucked it from under the upper and lower aft skins to do the final size holes. I just went to final size with it tucked in as it was for pilot size drilling, and the rivets easily went into the main spar. Disassembling the leading edge skin just to bring the aft edges to the outside of the aft skins may introduce more problems than it solves, because the burrs can add scratching and cause the skins not to sit as tight as when initially tucked.
42. Drill the upper forward skin to the forward ribs. I used a .125" drill to final size the holes. *Note 2/7/07 plans update from Sonex shows to drill these holes with a #32 drill (0.116"). This appears to be designed to coincide with use of the rivet-puller type dimpler tool, where a small "nail" passes through the hole to tie the two dimple dies together. I did not do this (built the wing prior to the plans revision), but I suspect a .116" hole will be too small for traditional dimple dies used with a c-frame dimpler. For this step, I do not intend to contradict what Sonex has published, and I leave it completely up to the user of these pages to determine how to make the holes to be dimpled.
43. Tuck the lower side of the forward skin between the aft skin and the spar. This is where having the wing up on blocks comes in. It may help to have a line drawn on the aft skin 3/8" from the edge to sight on to get the right edge distance. If using an extra-length vacuum-formed skin, watch that the extra length does not catch on an aft rib. This will prevent the

skin from cinching in the right amount. Also don't have the tie-down bolt installed on the spar at this point – it will catch on an extra-long vacuum-bent skin (ask me how I know). Tucking in the skin from below like this is the most difficult operation of this method of setting things up. Reason not to just turn the wing over now: TWIST IS NOT LOCKED IN YET.

44. Add straps to the assembly, 2x4 blocks in the aft spar to prevent the straps bending the aft spar. I used 4 straps, evenly spaced.
45. Add 2 2x4's under the straps near the forward edge to help pull the skin in. 2x4's should be continuous for the length of the wing, not just under the straps.
46. Drill the lower forward skin to the spar from below. Every 5th to 10th hole is fine. For the first hole or two, check that you are hitting the pilot holes previously drilled in the spar with the aft skin. If the spar holes are shifted inboard/outboard from the skin holes, the wing is twisted, and the blocking will need to be adjusted. Once the lower forward skin is clecoed to the spar, the twist (or hopefully lack thereof) is locked in.
47. Adding the root doubler: Remove the root rib and drill the holes in the root doubler from the inside out. I started at the upper aft end working forward along the upper side of the wing, made the bend for the leading edge by hand, and then worked back along the lower side of the wing. A reference line 5/8" in from the inboard edge of the doubler is good for reference here (the doubler overhangs the skin by 5/8" for initial fitting). Don't worry about the holes at the aft spar, these are caught later.
48. Turn the wing over, to bottom side up.
49. Drill the remaining holes in the lower forward skin, starting at the spar and working forwards. Don't drill the root rib to final size at this time.
50. Replace the root ribs.
51. Drill the root ribs and root doubler to final size holes. With this order of operations, it is not possible to get to the root doubler holes at the spar. These holes are caught later.
52. Disassemble down to what has not been deburred. What remains in place are the main spar with the aft ribs and spacers less the root rib, and the aft spar.
53. Add the gussets to the root ribs, replace root ribs on the wing assembly, and final size at all root rib mount bracket holes.
54. Debur the leading edge skin.
55. Drill/install the pitot tube fasteners in the RH leading edge skin.

56. Debur the forward edge and inboard edges (root doubler holes) in the upper and lower aft skins.
57. Cleco the root doubler to the aft skin and run through the doubler holes at the spar (upper and lower aft skins). I also caught the aft spar holes this way.
58. Check skin perimeters are deburred.
59. Cut aft spar at outboard end to match the skin line marked earlier.
60. Dimple the forward skin, only the rib holes (not the spar holes), and not the root rib or root doubler holes. I used a c-frame and 1/8" dimple dies, but there have been many ways developed to do this.
61. Debur root ribs all around.
62. Debur forward ribs and dimple. I used the 1/8" dimple dies welded to a vise-grip plier from Avery for this.
63. If adding electrical conduit, drill ribs chosen for the conduit. I used the forward tooling hole in the forward ribs, with brackets on 4 of the outer ribs to bring the conduit back to the aft tooling hole at the outermost rib. If I later add a landing light to the outer bay, the conduit will be aft of it. I wanted the wiring to be as far forward as possible because getting the CG forward in a Sonex is harder than getting it aft.
64. **Section 4**: Final assembly: Recleco the forward ribs in place.
65. Rivet the aft ribs to the aft spar. Leave out the two ribs closest to the root rib for riveting access.
66. Rivet the forward and aft root ribs to their mount brackets.
67. Replace the aft ribs closest to the root rib and finish riveting the ribs to the aft spar.
68. Rivet the forward and aft ribs to the spar. I found this took quite a while since the rivet gun doesn't fit against these rivets. I used an angled spacer and bent the rivet stems a little to get the gun up to the rivet in position. May also help to clamp the ribs with c-clamps close to the rivet locations – there's 5 thicknesses of metal being riveted here, and it's hard to get it all pulled down (especially with hand-hammered ribs).
69. Install the aileron pushrods (at least the hardware that goes on the bellcrank, but if you have the rods, they can be added here as well).
70. Install the tie down bolt. I found it only needed 1 spacer washer between the bolt and the bracket rather than the 2 called out in the print. Still needed multiple washers on the back side though to prevent the nut bottoming out.

71. Install electrical conduit.
72. Install the pitot/static tubing, RH wing only.
73. Place wing bottom side up.
74. Cleco lower aft skin onto the assembly, and rivet it in place less the flap hinge location, the root doubler location, and the main spar rivets (all these get done later).
75. Install the aileron bellcrank cover plate in the wing skin.
76. Turn wing over to top side up.
77. Set wing on blocks just aft of the main spar and level the wing on the sawhorses as described earlier.
78. Add upper aft skin to assembly. Rivet it on except for root doubler location, aileron hinge location, and main spar rivets.
79. Add the forward skin to the assembly. Cleco at several locations along the main spar, top and bottom. Clecoing the aft skins top and bottom to the main spar locks in the twist (hopefully lack thereof) into the wing. Just clecoing the upper skin because it's easy to see does not lock in the twist.
80. Rivet at all upper forward skin locations including main spar except for root rib/root doubler locations.
81. Turn wing over to bottom side up.
82. On the RH wing, before riveting the leading edge skin to the main spar, check that the pitot/static nutplates clear the rib. If not, rib flange may be bent or trimmed at the nutplate locations.
83. Rivet the leading edge skin to the main spar, then the countersunk rivets on the ribs, except at the root rib/root doubler location.
84. Debur the root doubler and cleco in place.
85. Wing is "done" until the tip rib installation and addition of the flap and aileron hinges.
86. To avoid a difficult hinge pin installation, put the hinge pin in place on the flap and aileron off the wing. Drill it for the cotter pins, install the cotter pins, then add the whole assembly to the wing, riveting the hinge to the wing with the flap/aileron already installed. This gets done after the wing is rigged to the fuselage.