Making a Dual Band S & L Patch

I have been working on dual band patches for 1269 MHz and 2401 MHz too, as there is considerable interest in using the 1269 MHz uplink frequency into AO-40. Also shown to the right of my two S & L patches is my good old S & U dual feed.

The first version was made by placing an S band circular patch and reflector and an L band patch & reflector side by side on a plate. This worked OK, but resulted in 8" of separation between the patch centers, and about 10 degrees of pointing difference on my 10' dish. This version was built so readers can use their G3RUH, etc. S band patch along with a 1269 MHz patch. Too much much separation resulted in very poor performance.

The next try took just the two patch plates and put them on a common reflector plate. This reduced the center to center spacing to 4" or 5 degrees on the 10' dish. While this might be OK on a long focal length dish, it is marginally acceptable on a short focal length TVRO dish. The larger reflector impacts the dimensions of both the S and the L patches, and requires modifying the single patch dimensions slightly.

Another major concern is desensing by the close proximity in spacing and frequency of the L patch to the S patch. The AIDC 3731 showed no desensing with full power (3 1/2 watts at the L patch), but a UEK-3000 downconverter would desense with as little as 1/5 watt at the L band patch. By placing a 4" high shield between the two patches, the UEK-3000 desensing by the nearby L band patch was cured, but this high shield distorted the dish illumination.

Axial Circular Dual Band (S & L) patch feed

I wanted to make a dual band S & L patch feed that would have both patches on an axial line with no bearing offset problem. After a bit of experimentation, I did it.

I was concerned that the 2401 MHz patch's reflector is sometimes bigger than the 1269 MHz patch so I made the 2401 MHz reflector smaller than usual. I was also concerned about minimizing desensing possibilities so I did not try to use the 1269 MHz patch as the 2401 MHz reflector. It worked!

The picture at the left shows the dual band circular S & L patch attached to the front of a 7 1/2' TVRO dish in place of the former C Band feed. The dual band patch uses 4 disks. And a few tricks. It may get somewhat confusing, but try to follow the logic. Here is how you can build one (or more) in a few hours for about $20 in parts.

Start by cutting out the 4 disks. Except for the the 2401 MHz patch (the smallest disk, in the front) which is 1/32" (1/16" would be easier to tap) brass for solderability, the disks are made from 1/16" aluminum. Cut the rearmost 1269 MHz reflector to 6 5/8" diameter. Cut the 1269 MHz patch in front of the 1269 MHz reflector to 4 3/8" in diameter. The 2401 MHz reflector is next at 3 1/2" in diameter, and finally cut the 2401 MHz patch out of a piece of brass to 2 3/8" in diameter. I use K & S brass from a local hardware or hobby store rack. You could use a soup can lid but it's tough to tap.

Center Hole in all four Disks

Drill a 3/16" hole in the center of the 4 disks which will be used for axial alignment of the disks when a 10-24 bolt, 1 3/4" long, is passed through the disks. Make a mark anywhere on the brass disk that is 11/16" out from the center hole. This will be the point of attachment of the 2401 MHz coaxial connector and the centering hole for the larger holes in the bigger aluminum disks. Temporarily bolt the four disks together tightly with the brass disk on top. Now drill a hole through the mark on the brass disk and the 3 aligned aluminum disks below the brass disk. Remove the 10-24 bolt and mark one side of each disk as "UP".

2401 MHz Patch Plate

Put a mark on the brass disk 1/2" clockwise from the 1/8" feed hole, also 11/16" out from the center hole. Drill a 1/8" hole in the brass 2401 MHz patch at this point. Then tap this hole with a 6-32 tap held perfectly perpendicular to the surface of the 2401 MHz patch. Screw in a 1/2" long 6-32 flat head bolt from the "down side". Put a 1/4" wide hex nut on the "UP" side of the bolt, with about 1/8" extending downwards. Finger tighten the nut to avoid stripping the threads in the brass disk. This screw will be used to tune for best received circularity and strongest received signal (hopefully the same point). Set the brass disk aside for now.

2401 MHz Reflector

Now the 2401 MHz reflector is drilled out to attach a type N male long chassis connector. I have 2 male sizes in my connector collection. The shorter 3/4" version is not long enough to directly attach a downconverter. Drill out the off center 1/8" hole previously drilled to 3/8" exactly centering the drill on the 1/8" hole. Some chassis connectors have a bottom taper that may require as much as a 1/2" hole for center pin clearance. This type N male chassis connector is attached from the "DOWN" side with four 4-40 flathead 1/4" long bolts inserted from the "UP" side. Holding the connector centered in the 3/8" (1/2") hole with the outer edge of the connector parallel with the outer rim of the 2401 MHz reflector, mark where the holes will be drilled. Drill four 1/8" holes at the marks. Then turn the 2401 MHz over and counter sink bevel the holes from the "UP" side so the four flathead screws will attach as flush as possible. Now attach the type N Male long chassis connector to the "DOWN" side of the 2401 MHz reflector using the four 4-40 flathead 1/2" long bolts and 4-40 1/4" nuts. Another disk done.

1269 MHz Patch Plate

The 1269 MHz patch plate gets another hole on its "UP" side. Draw a line from center to edge, 90 degrees clockwise to the 1/8" feed hole previously drilled for the 2401 MHz feed hole. Now put a mark on this line 1 5/16" out from this center. This will be the 1269 MHz patch's feedpoint, 90 degrees out of phase with the 2401 MHz patch feedpoint. Bolt the center of the two 1269 MHz disks together with "UP" up, patch on top. Then temporarily lock the two plates' orientation together by putting a short 4-40 bolt through the 1/8" holes drilled in each. Now drill a 5/32" hole at the mark on the line for attaching the 1269 MHz coaxial center pin.

Unfasten the two plates and drill a 3/8" hole centered on the 1/8" alignment hole. Dig out your old 1" Greenlee tube hole punch and punch a 1" hole in both the 1269 MHz reflector and 1269 MHz patch plate for the 2401 MHz feed to pass through. Set the 1269 MHz patch plate aside.

1269 MHz Reflector

The disk with the most holes will be this 1269 MHz reflector. Orient the disk with "UP" upwards, and the 1" hole to the left. The 5/32" hole drilled in the previous section should be at the top. Place a mark 1" clockwise from this 5/32" hole, also 1 5/16" out from the center. This hole will be used for the circularity

adjusting bolt. Drill a 3/16" hole at this mark. Now draw a line across the top of the disk, starting at the 5/32" feed hole continuing through the center hole to the opposite edge. 2" out from the center, place a mark on this line for the frequency adjusting screw. Drill a 3/16" hole at this mark too. Tap out both 3/16" holes with a 1/4-20 tap, keeping the tap perpendicular to the surface of the plate.

Drill out the 5/32" hole to 3/8" for the type N female chassis connector, making sure you keep the 3/8" (1/2") hole centered to the 5/32" hole. Then, while holding this female chassis connector centered in the hole and the edges parallel with the rim of the disk, mark the four holes that are used to attach the connector. Drill the four holes with a 1/8" drill. From the "UP" side counter sink bevel the 4 holes so that four 4-40 flathead 1/2" long bolts will lie flush.

The final holes in the 1269 MHz reflector plate are used to attach this dual patch to a dish using the original mounting arms used with a Chaparral C Band feed. The Chaparral feed was attached to the arms from a four 1/4-20 bolts in a 4 1/8" square pattern. The exact pattern is not particularly important, but I like things squared off, so after making a 4 1/8" square pattern, I hold this pattern on the 1269 MHz reflector plate so that the sides of the square are parallel/perpendicular to an axial line drawn between the two feed holes in the plate, and centered. Then I place a mark at each corner and drill a 1/4" hole at the four marks for mounting bolts. Put on four 1/4-20 hex head bolts from the "UP" side and fasten with a nut on the "DOWN" side, along with an additional nut and wingnut on each bolt for precise focusing.

Attach the type N female chassis connector to the "DOWN" side of the 1269 MHz reflector plate using four 4-40 flathead 1/2" long bolts and 4-40 1/4" nuts. From the "UP" side of the 1269 MHz reflector plate screw in a 1" long 1/4-20 flathead bolt into each of the two 1/4-20 tapped holes from the "UP" side. Leave extended about a 3/8" high and place a 1/4-20 nut on the "DOWN" side of each bolt to lock it in place after calibration. Finger tighten only, to avoid stripping the threads in the plate.

Assembling the Dual Band S & L Patch

In reverse order, or "bottom up" sequence, place a 1 3/4" long 10-24 bolt through the center hole in the 1269 MHz reflector plate from the "DOWN" side. Fasten with a 10-24 hex nut and firmly tighten. Now put another 10-24 nut on the the 10-24 bolt and adjust so that a 1/2" space between the plates will result. The center conductor of the type N female chassis connector has to extended. I cut the head off a 3/4" long brass 6-32 bolt and sharpen the cut off end on a grinder so that the end result is about 5/8" long. I tin this sharpened end the center conductor of the type N female chassis connector. Holding the sharpened end on the center conductor, I solder the two together, making sure this center conductor extension is standing up straight, perpendicular to the surface of the 1269 MHz reflector.

Place the 1269 MHz patch plate on the center mounting bolt and align the patch plate so the 1" holes match and the feed screw goes through the 5/32" feed hole in the patch plate. When appropriate adjustments are made if needed, remove the patch plate, put a 1/4" wide 6-32 hex nut on the screw so the patch plate will be spaced 1/2" from the reflector, put back the patch plate and add another 10-24 nut and 6-32 nut to hold firmly in place. Make sure the patch plate is spaced 1/2" from the reflector all around and the connector extending screw is not being pulled up, potentially breaking the solder joint.

Put another 10-24 nut on the center screw, placed so another 1/2" of plate to plate separation occurs, and place the 2401 MHz reflector on the center hole, with the type N male long chassis connector extending through the center of the 1" holes in the 1269 MHz reflector and 1269 MHz patch plate. Now put another 10-24 nut over this center screw to lock the orientation perfectly centered.

Put a 10-24 nut on the top of the last nut, snug it up and verify that you have 1/4" spacing. If your nuts are not exactly 1/8" thick like mine, then use washers to achieve 1/4" spacing between the 2401 MHz reflector and the 2401 MHz patch plate. Align the 1/8" hole in the 2401 MHz patch plate with the center conductor

underneath. Add a final 10-24 nut to the center bolt to lock the 2401 MHz patch plate to the assembly. You can use a small wire to bridge a gap if if you center conductor is short, but I usually just form a solder bridge between the center conductor and the 2401 MHz 1/8" feed hole.

K5MAN has made the following mechanical drawings in *.pdf format for those confused by my verbal description. S band patch. L band patch. S & L side view

Attach this S & L dual band patch in place of the C Band Chaparral feed horn. Connect 1269 MHz coax to the type N female connector, and put a downconverter on the type N male long connector. An AIDC 3731 is shown in the picture at the right. Attach a coax line with a type F male connector to the down converter.

Calibration

I find that if I have exactly followed the dimensions and set the three tuning bolts as will be detailed, the patch will work very close to perfect without further adjustment.

Loosen the 6-32 locknut on the 2401 MHz patch plate and turn the **front screw** so that it is spaced .020" or the thickness of 3 "bingo" postcards above the reflector. Loosen the 1/4-20 locknut on the frequency tuning bolt **furthest from** the 1269 MHz type N connector. Turn the 1/4-20 flathead bolt so that it is as far from the 1269 MHz patch plate as possible. Loosen the 1/4-20 locknut on the circularity tuning bolt **next to** the 1269 MHz type N connector, and turn the bolt so that it is just touching the back of the 1269 MHz patch. Note the position of the slots on this flathead bolt and turn the bolt back exactly one turn (.050") or 7 "Bingo" postcards separation. These setting will be very close, but you can use the frequency tuning 1/4-20 bolt **furthest from** the 1269 MHz type N connector to trim the 1269 MHz patch to exact frequency. I achieved an almost perfect match when this frequency tuning bolt was 3 turns back (.150") from touching the rear of the 1269 MHz patch.

Does it work?

I used this patch for the first time on a 7 1/2' dish. The AO-40 beacon came in just over S9 +15, and was exactly 20 over S9 on my 10' dish. Although the squint was rather high for L band operation at 30 degrees, the return voice signal strength was about 3 db or so higher than an occasional Leila bleeping nearby. And I was only running about 3 watts at the time on L1.

Sources for the type N connectors

Some people have e-mailed me telling me that they were unable to located some of the type N connectors and adapters used on these multi-band circular patch feed systems. I got the type N male chassis connector, long, from Radioshack.com, but they went out of business last Summer, and I have been unable to find any more. I now use the short standard version which works fine. Pasternack (949) 261-1920 has these connectors (PE4131) for $8 each as well as the double male (PE 9007) and the double female (PE 9006) also at $8 each. Their type N female chassis connector (PE4013) is $5 each. Hangar 19 in Texas may also have these connectors and adapters at more reasonable prices (around $3 to $4 each). Avoid the cheap plastic insulated type N connectors. They melt when soldered, and sometimes result in a patch impossible to tune for low SWR.