BAND SWITCH REPAIR OF THE HP 8555A SPECTRUM ANALYZER RF SECTION

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March 15, 2010

INTRODUCTION

The Hewlett Packard model 8555A spectrum analyzer dates back to the 1970s, but is still very commonly used by amateur radio operators interested in microwave communication. It is truly a tribute to the quality of these instruments that they typically still work quite well after 30-40 years of service. The instrument is usually paired with an HP 8552B IF section and both are typically mounted in an HP 141T display section. Our group of microwave experimenters in eastern New York and western Massachusetts own five HP 8555As.

HP Model 8555A Spectrum Analyzer RF Section (on top) With Model 8552B IF Section, Mounted In A Model 141T Display Section

Over the years, the band switches in more and more of these units have failed completely or partially. (HP sometimes calls the band switch a "Frequency Band Shaft Encoder"). In fact, 3 of the 5 units our group owns failed completely and one failed partially. It appears that a band switch failure is very common on a great many 8555As as they age. The reason became evident as we worked on the switch. See the repairs described below.

Even if the band switch fails completely, the analyzer can still be used normally on the 10 MHz to 2.05 GHz band where the switch contacts are all normally open. The analyzer can also be used on the 4.11-6.15 GHz band as long as the operator realizes the signal identifier function will work backwards on this band. Finally the analyzer can be used on the harmonic bands with a bad band switch, but the specifications are seriously degraded. Among other things, the band switch and associated circuitry changes the mixer bias and the instrument IF gain on the harmonic bands to improve mixer conversion loss and maintain amplitude calibration. The band switch circuitry also actuates relays for the 1.5-3.55 GHz and the 2.6-4.65 GHz bands. Those bands cannot be used with a failed band

switch. The 8555A also cannot be used with an external mixer above 18 GHz if the band switch has failed. Clearly the band switch should be repaired if at all possible.
Unfortunately the full HP Operating and Service Manual does not provide detailed instructions of how to disassemble the band switch or how to adjust it, just a marvelously detailed drawing of the Tuning Head Assembly. No text instructions are provided for how to work on this beautiful mechanical marvel. A search of the Internet turned up very little information about fixing the 8555A band switch. Only a single reference was found to an E-Mail posted by G3LTF in 2004 on the "moonbounce board". Still, this document steered us in the right direction and the complete text is included in the appendix. Many thanks to Peter Blair – G3LTF!

The goal of this paper is to provide detailed step-by-step instructions of how to repair the band switch with lots of pictures to illustrate the task. The work is delicate, but should be possible for most amateur radio operators with good mechanical skills and some small tools. A drill press is also essential to complete the repair. The repair is actually easier and quicker than we thought it would be. It took about 4 hours the first time done slowly.

Summary

As mentioned above, the repair of the band switch is not as difficult as it might seem. This document is long and detailed to ENCOURAGE owners to make the repair, not to scare them away! A summary of the work required is given below:

1. Remove the front panel assembly from 8555A RF section.
2. Open circuit board side of dial drum assembly revealing band switch
3. Remove plastic spider from circuit board
4. Bolt contact fingers back onto the plastic spider
    a. Cut off old plastic bumps
    b. Drill new holes
    c. Use ¼ inch 0-80 bolts and nuts to re-attach contact fingers
5. Re-assemble spider to the switch circuit board
    a. Adjust spacing of spider to put gentle pressure on the contact fingers for reliable contact but so the attachment screws do NOT make contact.
6. Re-assemble the circuit board switch into the dial drum assembly and test
    a. Remove and adjust if binding, scraping or electrical issue is noted
7. Re-assemble the front panel to the 8555A RF section
8. Test with live signals

REPAIR DETAILS

Diagnosis

Before beginning the repair, make sure that the band switch really has failed. Turn on the spectrum analyzer and let it warm up. Conduct the following tests. Any one or more of the following conditions indicate the band switch in the HP 8555A may have failed.

1. Switch the band from 0.01-2.05 GHz to the 2.6-4.65 GHz band. You should hear 550 MHz IF relays click in the RF section. If not, the band switch is suspect.

2. Switch the band from 10.29-18.0 GHz (N=4+ band) to the 10.31-22.55 GHz (N=6- band). You should hear the external mixer relays click in the RF section. If not, the band switch is suspect.
3. Set the analyzer to the 1.5-3.55 GHz band. Select the 10db/div log display mode. Select the 100 kHz bandwidth setting. Adjust the Log Reference Level switch on the IF section for about 1 division of noise "grass" at the bottom of the display. Switch the analyzer to the 22.65-43.05 band. The noise floor should rise typically 4 major divisions. If there is little or no increase in the noise level, the band switch is suspect.
4. Set the analyzer to the 0.01-2.05 GHz band. Connect the 30 MHz, -30 dBm Cal Output connector on the IF section to the input connector on the RF section. Set the analyzer to Bandwidth=100 kHz, Scan Width=1 MHz/Div, Input Attenuator = 10 dB, Log Reference Level Switch = 0 dBm, Log Reference Vernier = -10 dB. Tune the spectrum analyzer so the 30 MHz test signal is near the middle of the screen. Switch the band to 2.6-4.65 GHz band. The test signal should disappear completely. If it remains visible, the band switch is suspect.
5. With the Cal signal still connected, set the analyzer to the 0.01-2.05 GHz band (n=1-) again. Turn on the Signal Identifier slide switch. A second signal should appear 2 divisions to the left of the 30 MHz signal and a little bit smaller. Now switch to the 4.11-6.15 GHz (n=1+) band. The smaller signal identifier signal should jump to the other side of the test signal. If the identifier signal does not move, the band switch is suspect.
6. With the test setup left as above, switch to the 2.07-6.15 GHz (n=2-) band. The 30 MHz calibrate signal should change level and the signal identifier should be on the left of the main signal <u>but not spaced 2 divisions</u>. If the level of the main signal does not change much and/or the identifier signal remains spaced by 2 divisions, the band switch is suspect.
7. Continue the above test on other bands. For each band with a minus sign, the signal identifier should be on the left. For each band with a plus sign, the identifier should be on the right. For each different harmonic number (n), the spacing of the identifier signal from the main signal should change. The amplitude of the signal should also change with the harmonic (n) but it may go up or down depending on mixer bias and mixer loss compensation, but the amplitude of the signal should <u>CHANGE</u> with different n values. If the spacing and/or the amplitude of the test signal do not change with n, the band switch is suspect. Note the test signal will not appear on the n=6 or n=10 external mixer bands if the band switch operates that function correctly. Remember <u>partial</u> band switch failures are common. For example, the external mixer relays may operate correctly, but the switch may not encode band changes from n=1 to n=2, 3 or 4.

Before taking apart the analyzer, note any other intermittent switch that may need repair.

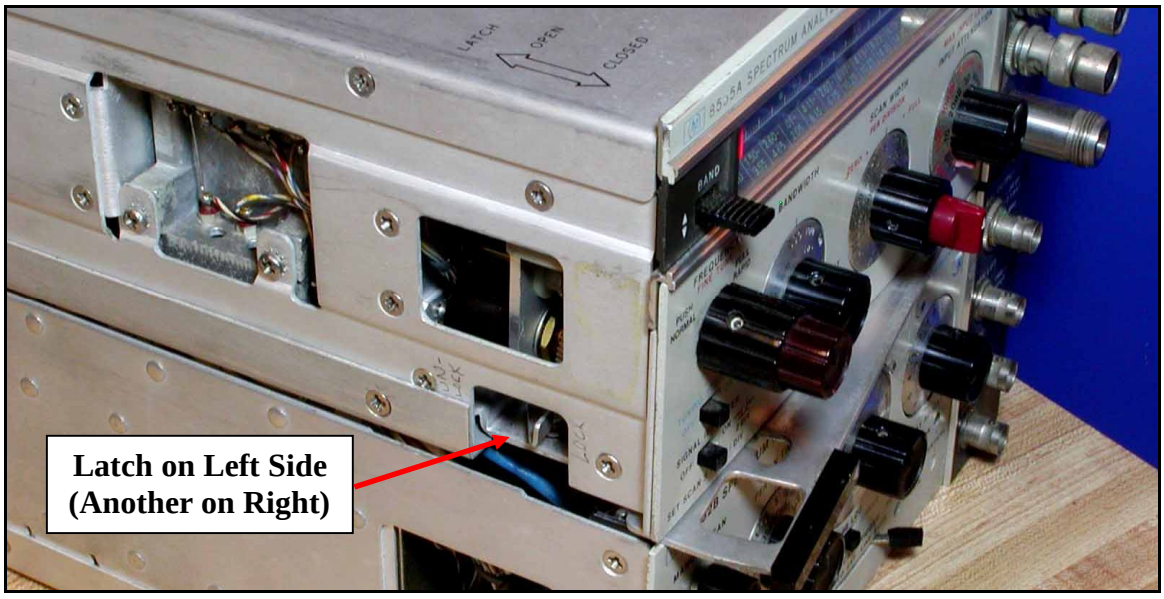
Disassembling the Analyzer

If the function of the analyzer as described above indicates that the band switch may have failed, turn off the power to the analyzer and unplug the AC line cord. Place the analyzer on a large flat bench and operate the lever between the RF and the IF sections sliding it to the left and pulling it out so that it pops out revealing a finger hole.

Release Lever Holding the Spectrum Analyzer Sections

Insert a finger and pull the RF and IF section pair straight out from the display section. It may be necessary to hold the display section with the heel of your other hand as you pull the RF and the IF sections out.

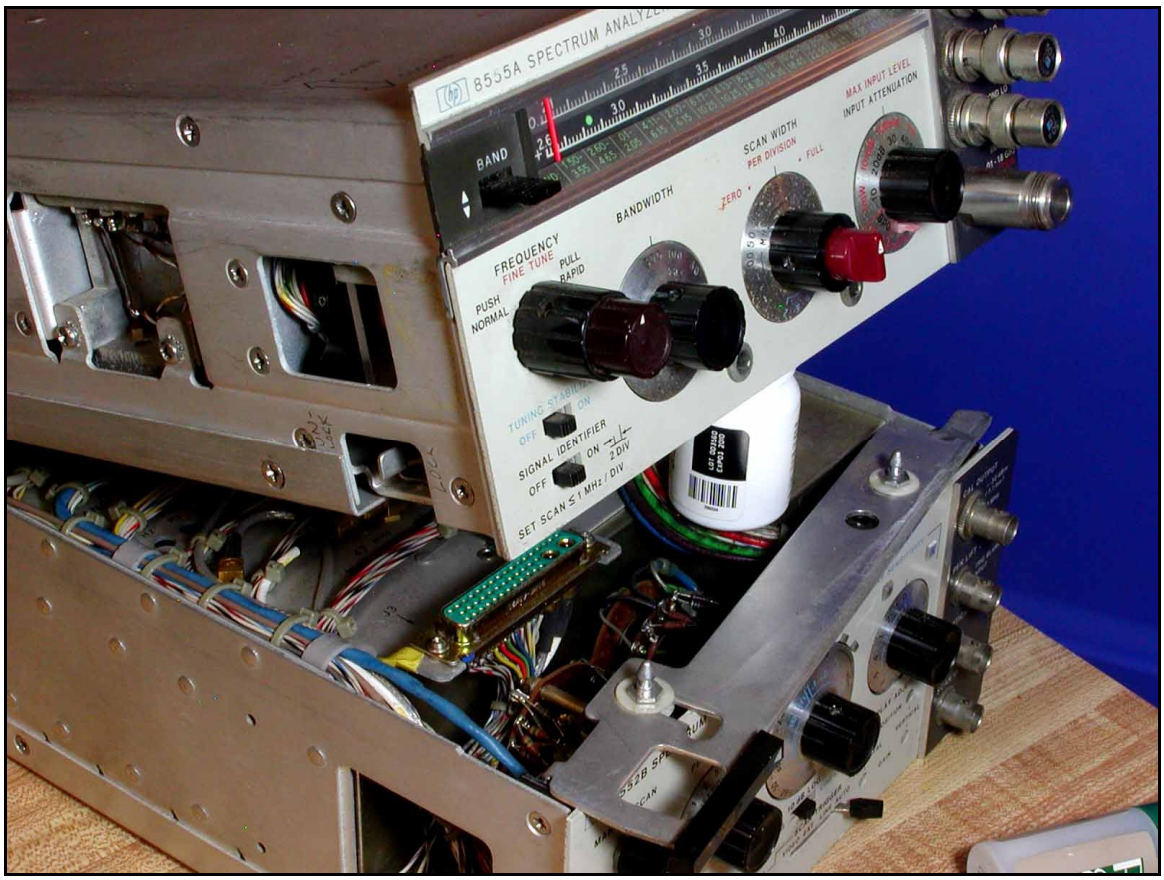
Pull Analyzer Straight Out of the Display Section



Push Back To Release the Latches on <u>BOTH</u> Sides of the RF Section

To separate the RF and IF sections, unlock the two latches at the bottom of the RF section near the IF section, by pushing them back away from the front panel. Then gently pull up on the front edge of the RF section until the connector between the RF and IF sections separates. Rocking the RF section (alternately raising the right and then the left sides)

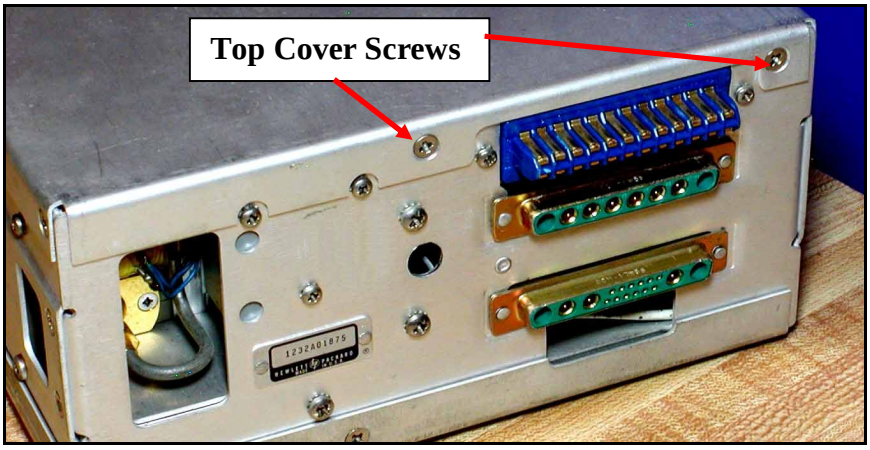
may help loosen the connector. If the connector fails to release easily, make very sure the 2 latches really are open before pulling a bit harder. Raise the front of the RF section a few inches, and then slide it back to mechanically unhook the 2 sections.



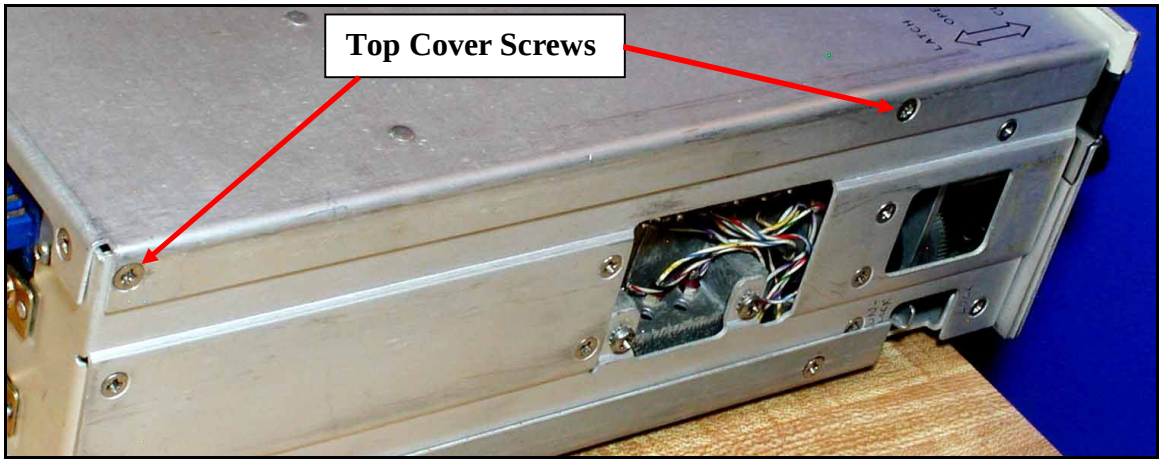
Lift the Front of the RF Section About 2 Inches to About the Position Shown, Then Slide It Backward To Separate It From The IF Section.
(A Pill Bottle Is Used Here To Hold the RF Section for the Photo)

Place the RF section on the bench being careful not to damage the connector on the underside of the unit. Remove the top cover. NOTE: The cover is fastened with POSIDRIVE screws that look like Phillips head screws but have a different kind of cross-slot. They can usually be removed with a Phillips head screwdriver but a #2 POSIDRIVE screwdriver is the right tool. Push in hard with a Phillips head screwdriver to avoid slipping in the cross-slot as you turn the screw. The photos below show the screws that hold the top cover. Remove 2 screws each from the right, rear and left sides of the unit.

Right Side of RF Section – Remove 2 Top Cover Screws

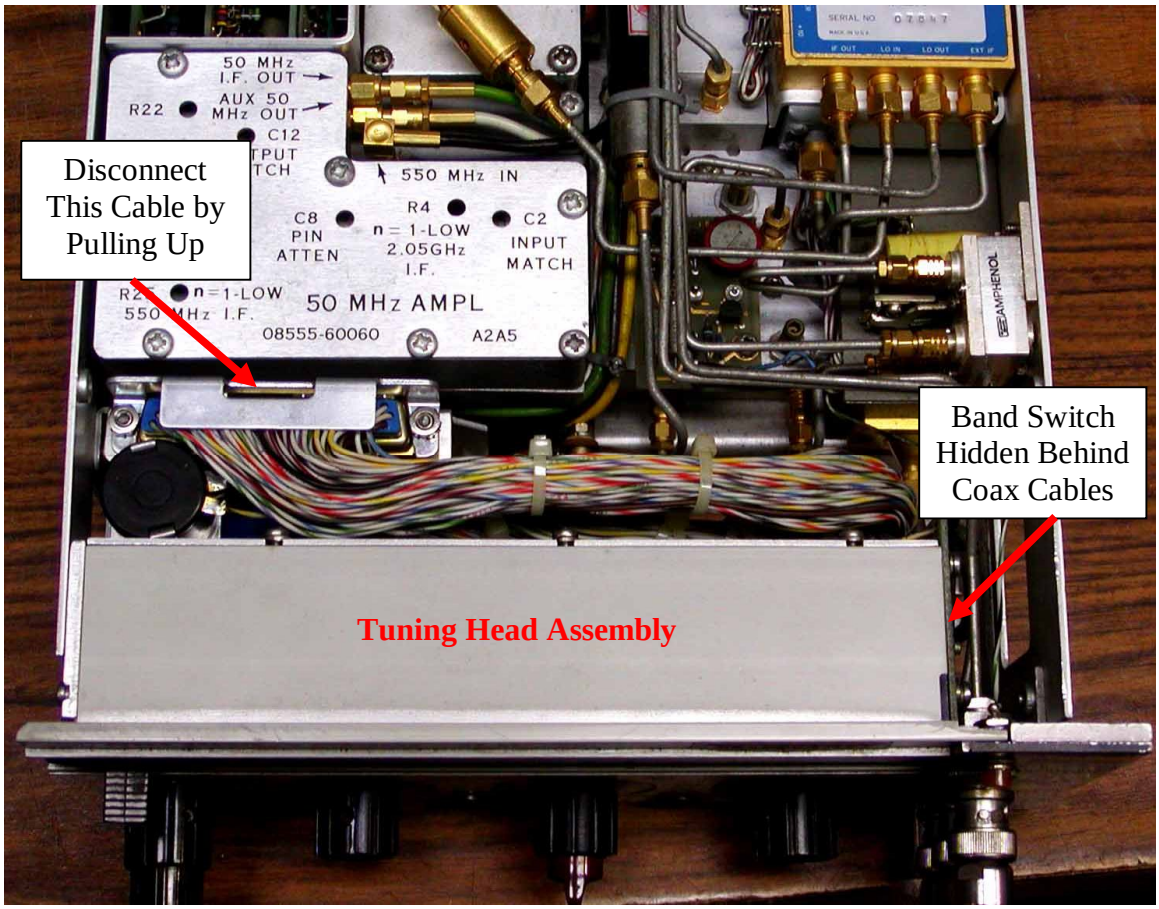


Rear of RF Section – Remove 2 Top Cover Screws



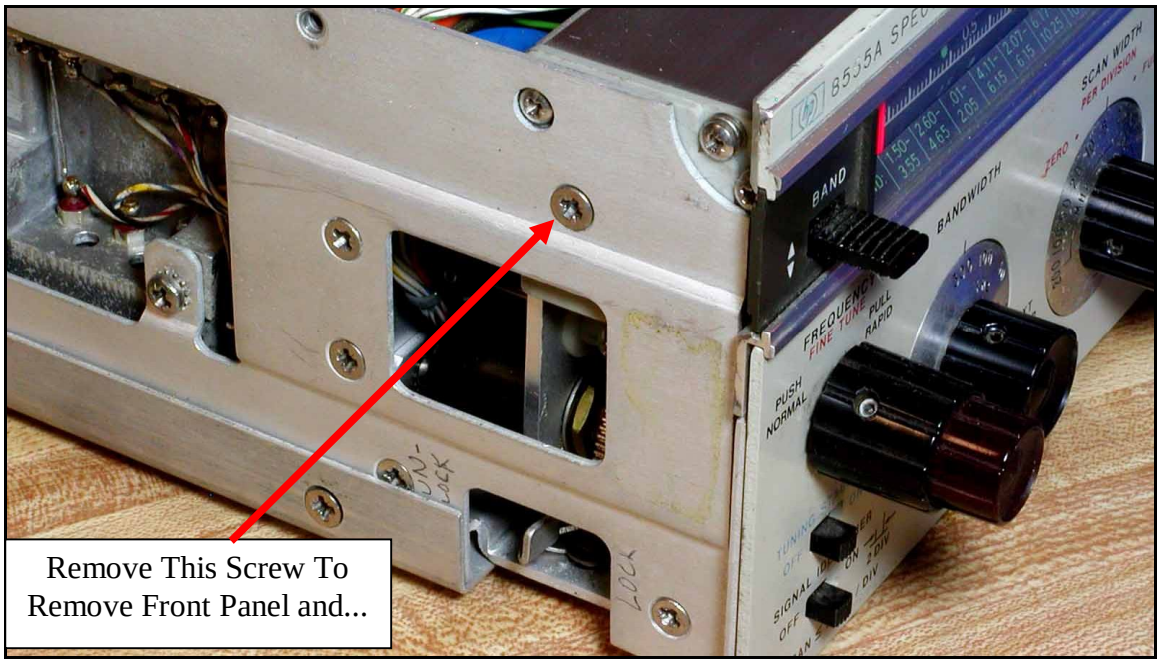
Left Side of RF Section (Viewed From The Rear) –
Remove 2 Top Cover Screws

Although the band switch on the tuning head assembly can be tested while the front panel assembly is still mounted in the RF section, the switch is much more accessible once the assembly is removed. In any case, the cable carrying the wires from the front panel to the rest of the RF section should be unplugged before testing the switch with an ohmmeter.

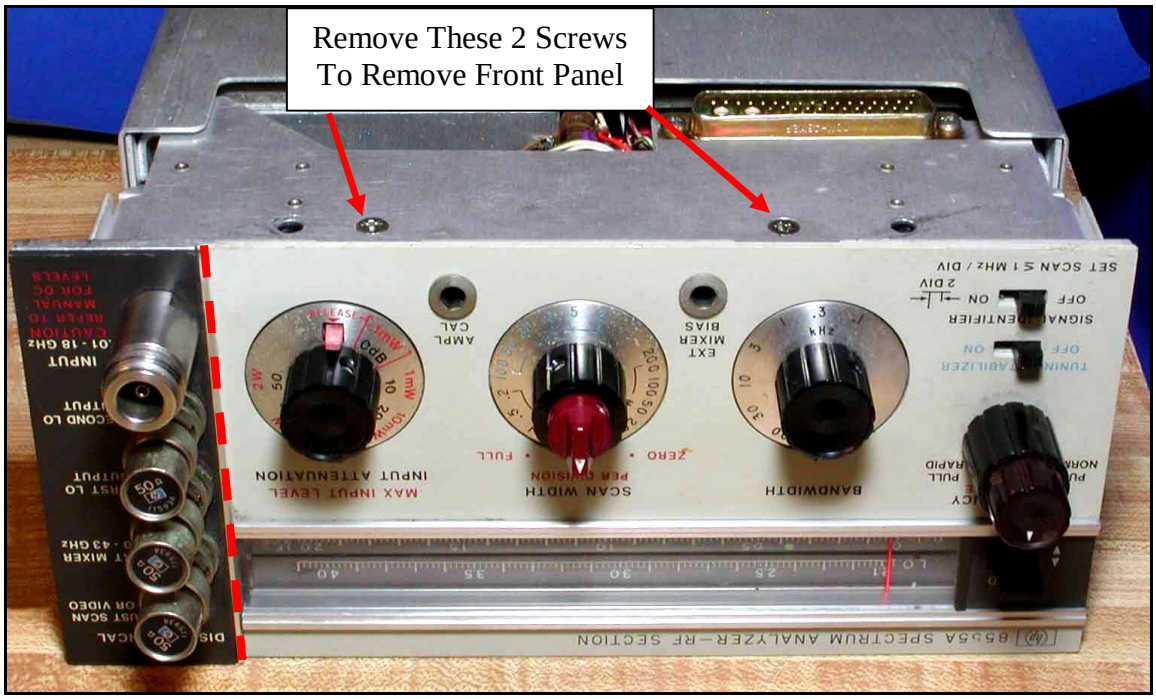


Top View Of HP 8555A RF Section

To remove the complete front panel assembly from the rest of the HP 8555A RF section, first remove the top cover and disconnect the front panel cable as shown above. Removing the bottom cover is not essential but is helpful, making the overall chassis mechanical assembly a little "looser" and the front panel easier to slide out. Only three screws hold the front panel in the RF section - one on the left side and two on the bottom.

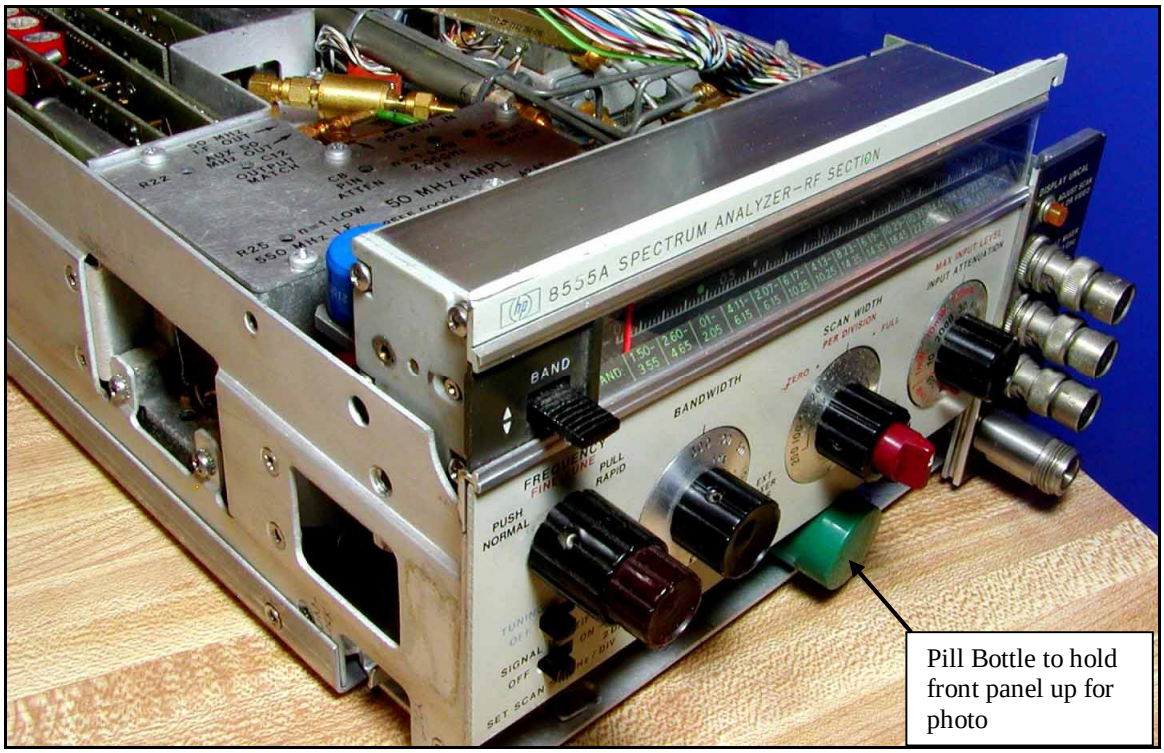


Left Side View of HP-8555A RF Section



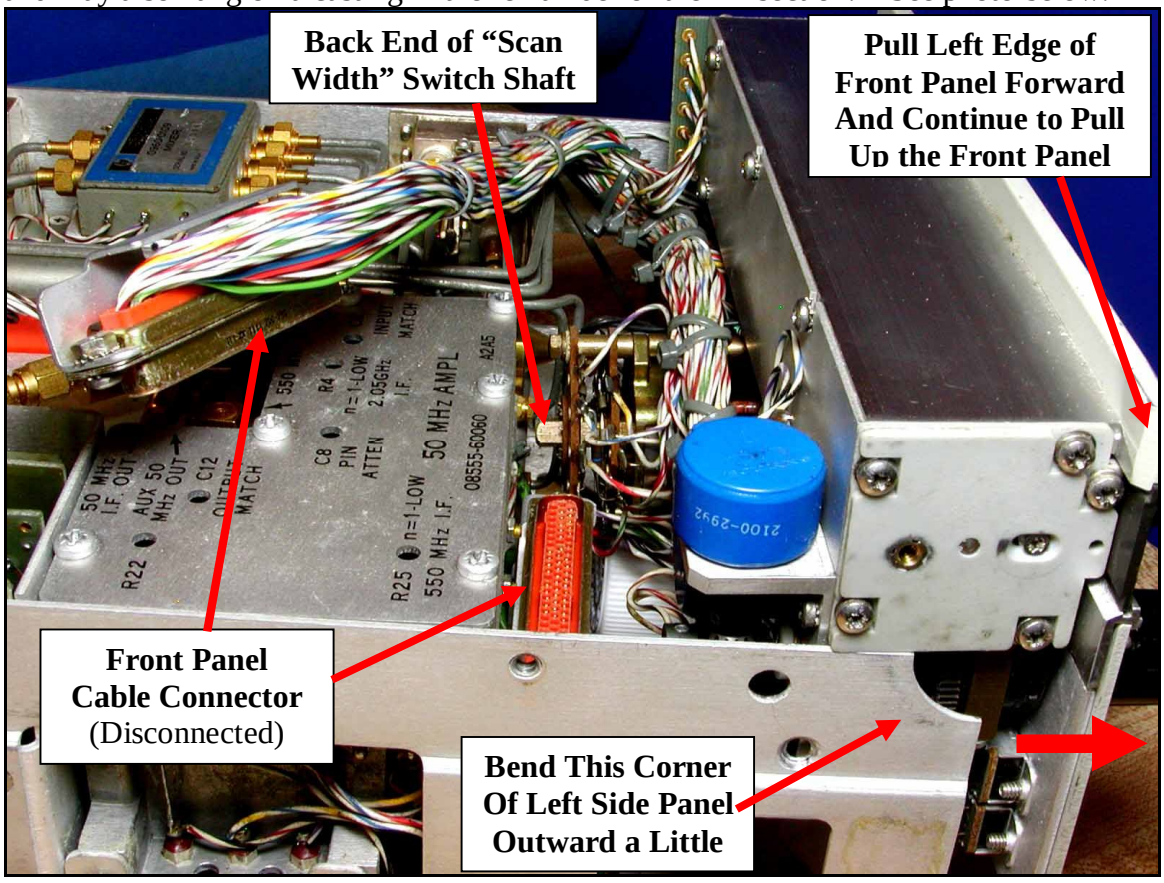
HP 8555A RF Section Upside Down – Panel Separates At Red Dotted Line

Once the 3 screws are removed the panel slides straight up, separating from the rest of the RF section leaving the RF connectors behind on a small sub-panel. Pull the front panel gently straight up taking care that the long Scan Width switch does not accidentally snag any wires or copper coaxial cables in the remainder of the RF section. This can be a little tricky so continue to read the hints below.



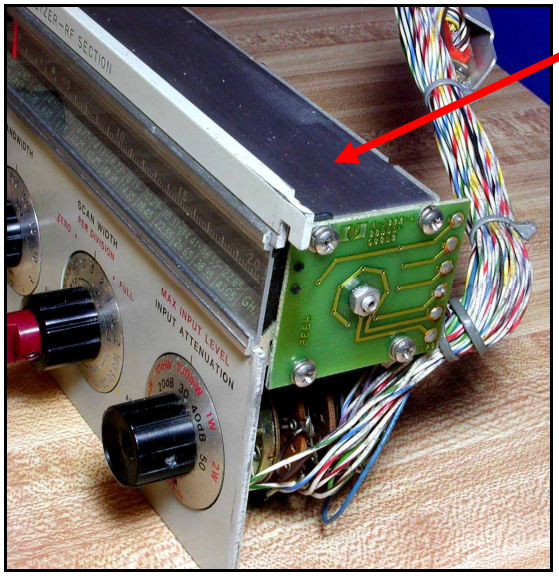
Pull Front Panel Assembly Straight Up About ¾ Inch

At this point, the back end of the Scan Width switch typically hangs up on some cables and may also hang on a casting in the remainder of the RF section. See photo below.

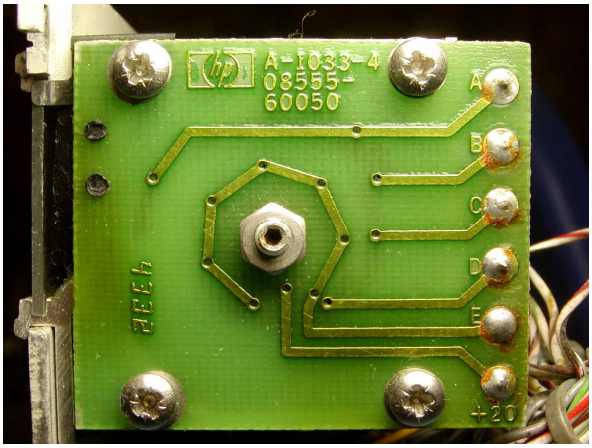


To free the front panel, push any interfering cables gently back out of the way. If the switch shaft still hangs up on a casting, gently bend the left wall of the chassis out just a little bit and pull the left edge of the front panel forward about 3/8 to 1/2 of an inch as shown in the photo above. Keep alert for other places where the front panel assembly may hang up. Then continue to carefully pull the front panel assembly up and out of the rest of the RF section. Be patient. The front panel assembly will eventually come out OK. There are no other mechanical or electrical connections. Don't break something out of frustration.

Front Panel Removed From HP-8555A RF Section



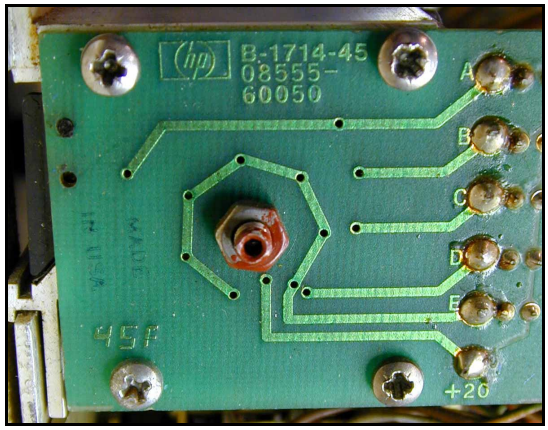
Band Switch On Front Panel



Band Switch Contact Circuit Board

Testing The Band Switch

The band switch is clearly visible at the right end of the Tuning Head Assembly shown above. The band switch assembly (AKA: frequency band shaft encoder) consists of a small piece of G-10 (FR-4) printed circuit board that holds the contact pattern and a set of contacts held by a plastic "spider" turned by the frequency dial drum inside the assembly. The switch in this photo is an early model. Later models have bypass capacitors added to each of the wires on the circuit board seen in the photo below on the far right side.



Newer Model Band Switch Circuit Board With Bypass Capacitors

The band switch can now be tested to confirm if it has failed or not. To make testing easier, it is useful to solder small stubs of solid wire to the band switch connection pads on the circuit board. Connect one lead from an ohmmeter to the common connection labeled +20 at the bottom of the circuit board. Then connect the other lead from the ohmmeter to the various other contacts labeled A, B, C, D, and E. The proper function of the switch is shown in the truth table below. Any error indicates the switch really is bad.

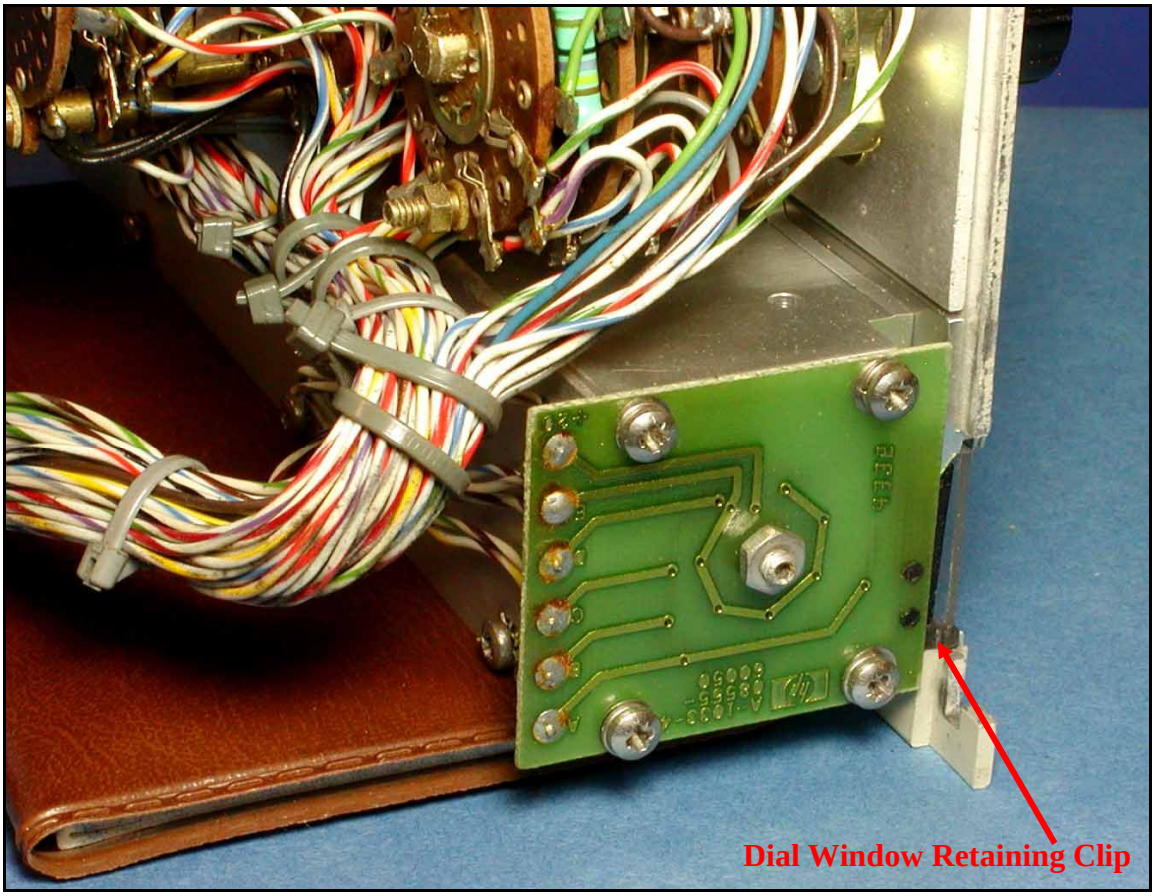
Frequency Band - GHz	Harmonic Number	Band Code ABCDE	Frequency Band - GHz	Harmonic Number	Band Code ABCDE
1.50-3.55	N = 1-*	**00010**	8.23-14.35	N = 3+	**01001**
2.60-4.65	N = 1+*	**00011**	6.19-14.35	N = 4-	**11000**
0.01-2.05	N = 1-	**00000**	10.29-18.45	N = 4+	**11001**
4.11-6.15	N = 1+	**00001**	10.31-22.55	N = 6-	**00100**
2.07-6.15	N = 2-	**10000**	14.41-26.65	N = 6+	**00101**
6.17-10.25	N = 2+	**10001**	18.55-38.95	N = 10-	**00110**
4.13-10.25	N = 3-	**01000**	22.65-43.05	N = 10+	**00111**

* Band uses 550 MHz first IF Band code 0 = open circuit. Band code 1 = connected.

Frequency Band Switch Removal

Before removing the band switch, select the 0.01-2.05 GHz band with the paddle actuator labeled **BAND** on the front panel. This makes it easier to replace the band switch correctly once it is repaired. To remove the band switch, place the front panel assembly face down on the table with some wooden or foam plastic blocks to stabilize it and keep

it from tipping. The front panel can also be placed upside down on the table with a thin spacer to support the Tuning Head Assembly. The point here is to keep the band switch near the surface of the table so any parts that may fall out during disassembly will not be lost.



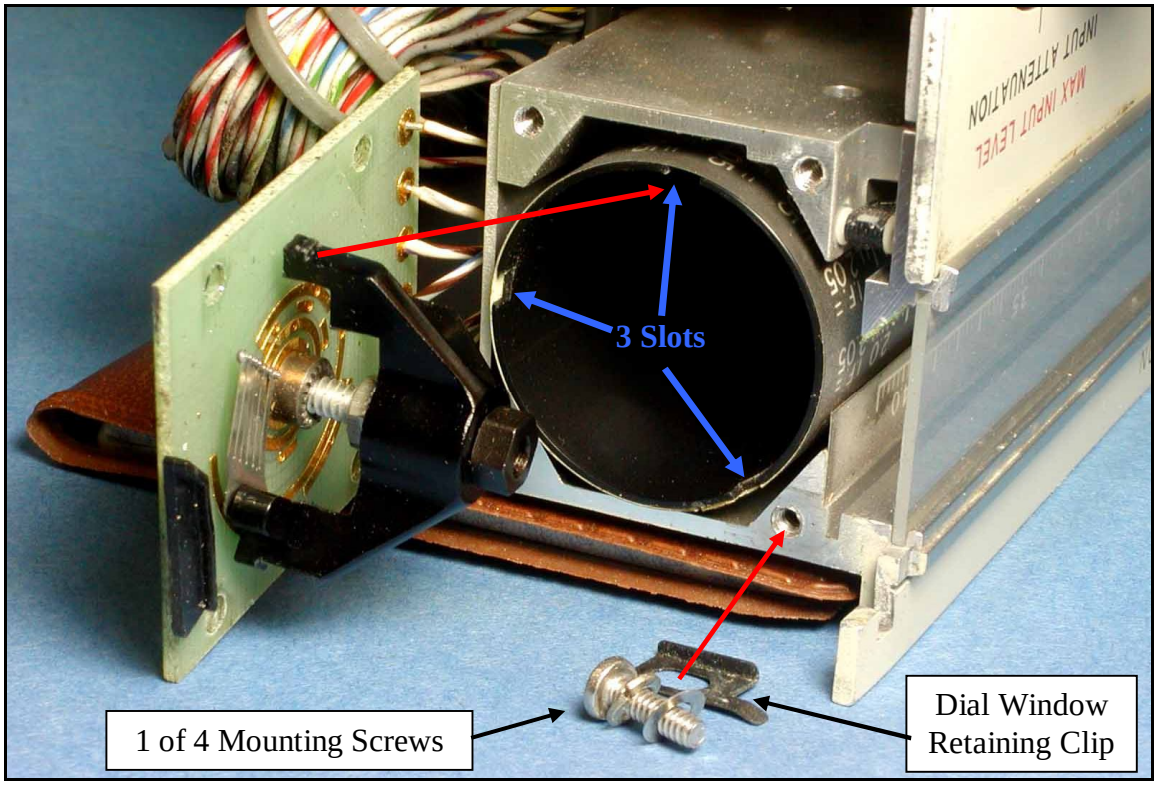
Front Panel On Table Upside-down (supported on a check book register)

Also, before disassembly, hold the front panel assembly with the band switch end down and gently shake it so any loose switch parts slide down inside the Frequency Dial Drum to the end where the switch is. You DON'T want to do this once the switch circuit board is removed and the dial drum is loose.

Remove the 4 bolts at the corners of the band switch circuit board and be sure to save the flat washers and lock washers on each. There is also a small black metal clip under the top-front screw that holds in the plastic dial window. Make sure you don't loose this either. DO NOT loosen or remove the hex Allen screw or its locknut in the middle of the circuit board at this time.

Gently pull the band switch circuit board away from the end of the tuning head assembly only about 1/8 to 1/4 of an inch. Recover and save the retaining clip for the clear plastic dial window if you have not already done so. It is sandwiched between the circuit board and the tuning head assembly top plate. Then use a small screwdriver to hold the black

frequency dial drum back in the tuning head as you pull away the band switch circuit board and its associated wires. Keep the drum near its original position so the intricate mechanical drive at the other end is not disturbed and its parts are not accidentally disconnected. During repairs of 4 different units, the band switches have always come out easily and have never stuck to the frequency dial drum, but still use caution here.

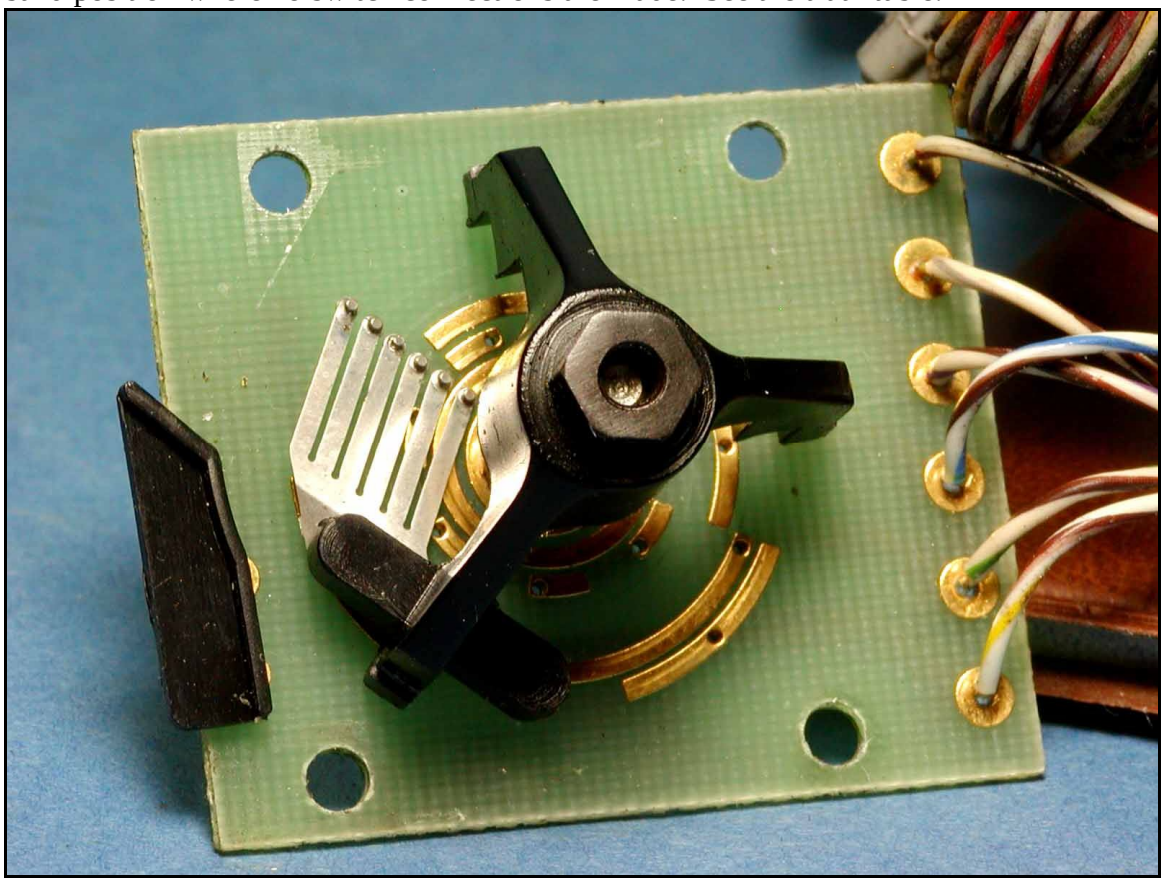


Band Switch Removed From End of Frequency Dial Drum

In the photo above the band switch has been dismounted from the Tuning Head Assembly. The switch consists of several gold plated traces on a circuit board and a metal contact finger set attached to a plastic "spider". The 3 arms of the black plastic spider engage in 3 slots cut in the frequency dial drum causing the contact fingers to rotate around the gold plated traces on the circuit board. The spider is held on axis by a center screw, but is captured only loosely between 2 nuts with about 0.020" of axial play. This allows the spider to turn freely and nest in the 3 slots of the drum. The switch contact pressure can be adjusted by how much the center screw is turned into the collar in the middle of the circuit board. A lock nut is used on the outside of the circuit board to maintain the proper adjustment.

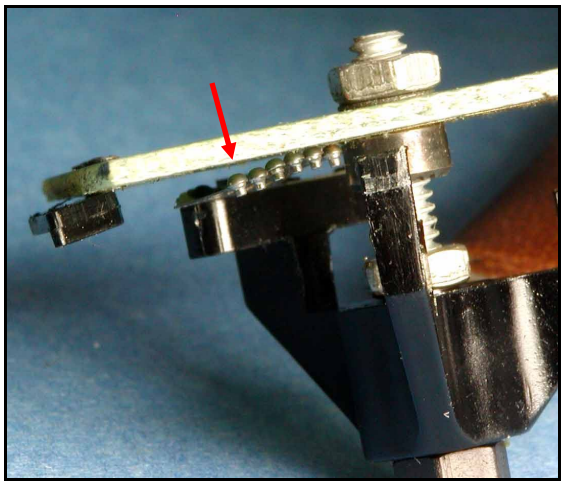
The contact set is actually a single piece of thin metal spring stock with 6 fingers. A small metal ball attached to the end of each finger makes contact with the circuit board traces. The innermost finger connects to the switch common trace that is an unbroken circle. The +20 volts on the common trace is then passes through the metal fingers and is applied to the various other segments of circular traces depending on the position of the

plastic spider (driven by the dial drum). The spider is shown below in the 0.01-2.05 GHz band position where no switch connections are made. See the truth table.

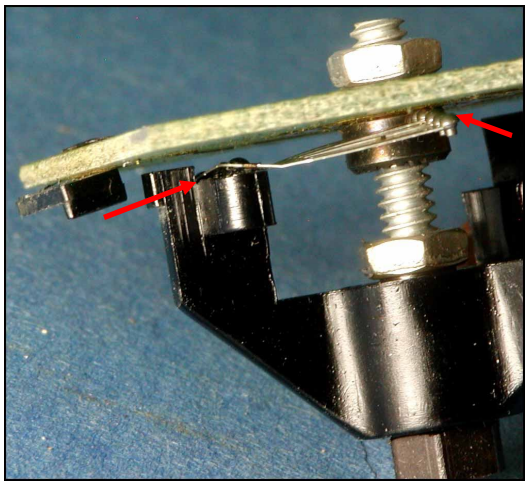


Contact Details of the Band Switch

The unit pictured above appears to have a working band switch with the contact set still in its proper place, but in fact the switch has partially failed, as the photos below show. The “heel” of the metal finger set has come from the black plastic spider releasing the spring tension on the outer 3 contact balls in the finger set. This explains why the n+/n- function and the 550 MHz IF bands still worked on this analyzer but the harmonic mixer microwave bands did not. Only switch bits D and E still make contact.



Only Half the Fingers Make Contact



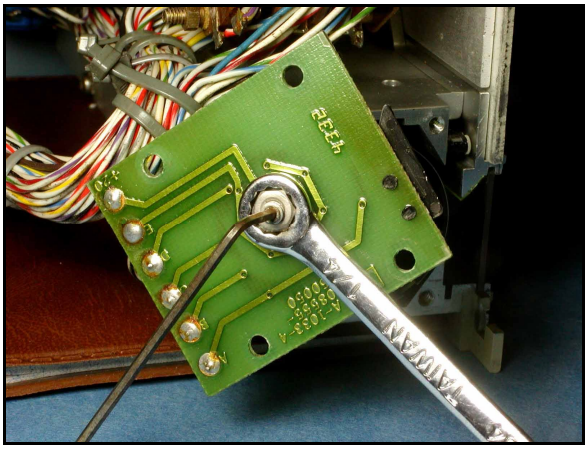
One End of Finger Set Detached

The photo above also shows the correct (original factory) adjustment of the switch adjustment screw. It should be set so the 3 feet of the spider ALMOST touch the circuit board, but not quite. There are no scrub marks on the board where the feet would have made contact, so they did not actually touch.

If the metal contact piece is not found on the black plastic spider, it has probably broken off and should be inside the frequency dial drum near the switch end of the tube. That's why the front panel was shaken earlier with the switch end pointed down.

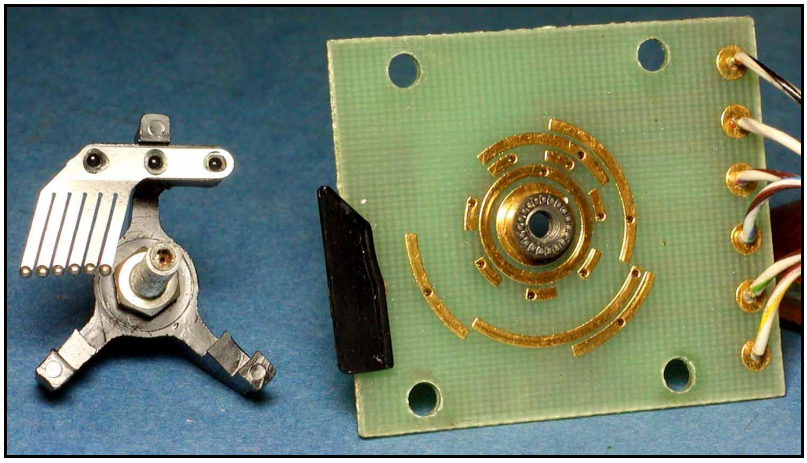
Frequency Band Switch Disassembly

Before taking apart the band switch, carefully count the number of turns that the adjustment screw sticks out of the jam nut so the switch can be reassembled to the original factory clearances as a starting point. Then take the band switch apart using a 1/16" (or 0.0625") Allen key and a 1/4-inch box wrench from an ignition wrench set.

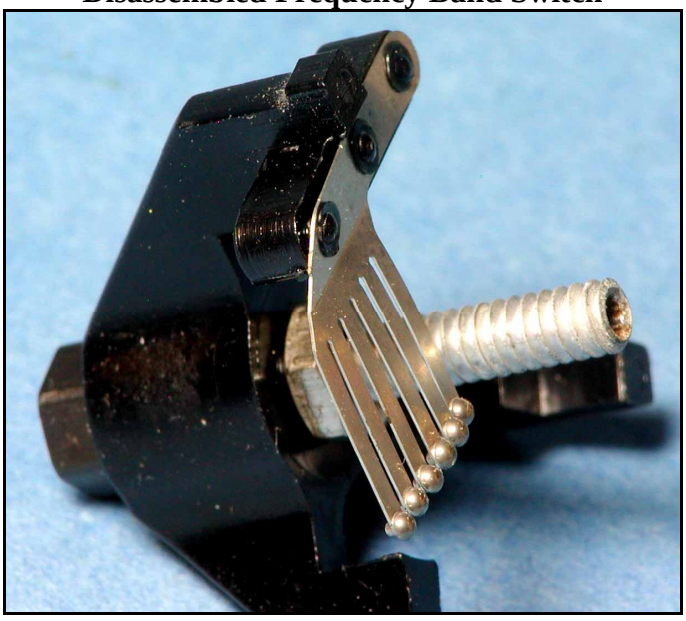


Loosen the Jam Nut With an Allen Key and ¼-Inch Wrench

Hold both the Allen key and the circuit board in one hand and then turn the wrench to loosen the jam nut. Remove the jam nut and then unscrew the adjustment screw with the plastic spider and contacts from the backside of the board. There is no need to remove the adjustment screw from the spider. The photo below shows the disassembled switch.



Disassembled Frequency Band Switch



Plastic "Spider" and Metal Contact Fingers

Photo above illustrates why these switches often fail. The metal contact finger piece has become detached from the plastic spider on the near end. It appears the contacts were originally attached to the plastic piece by compressing and melting 3 thin plastic pins extending through holes in the metal piece. Over many years of aging and stress, the melted plastic pins eventually become brittle and fail. Sometimes only one plastic pin fails leading to a partial switch failure but sometime all three fail, causing the metal piece to fall completely off. Four out of five spectrum analyzers owned by our microwave group have had these switches fail. It is likely that most HP-8555As will eventually have similar band switch failures especially if they are moved around a lot and have suffered mechanical shock. Luckily, these switches can be fixed relatively easily to be even better than the original design. Read on!

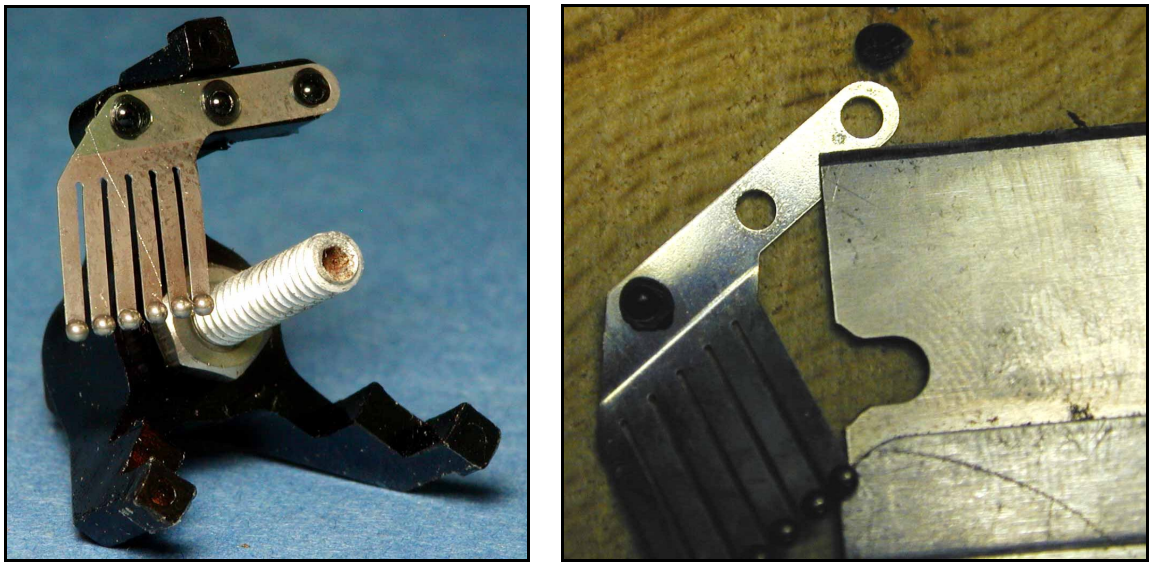
Some technicians have repaired these switches by simply gluing the metal fingers back onto the plastic spider. This is not a good plan. The glue typically fails again since the

joint is under constant tension from the contact pressure of the switch. One good mechanical jolt once the glue has dried out for a year or two, and the contacts fall off again. Two of the 4 units we fixed recently were repaired with glue once by a previous owner only to fail again now that we owned them! G3LTF suggested a better solution in his posting on the Internet in 2004. Use little tiny metal screws to hold the joint together and it will likely never fail again.

There are 2 disadvantages to using little screws. First, the screws are very small and are not commonly available. Second, the screw heads may interfere with the switch operation by touching the etched metal pattern on the circuit board. The 0-80 x ¼ inch screws required can often be found at local hobby & model stores or can be mail ordered from a well-stocked on-line hardware store like McMaster Carr in Chicago, IL. A screw with a low-profile head should be used to avoid mechanical interference. G3LTF suggested using flat head screws and countersinking the holes in the plastic spider slightly, but we have successfully used low-profile binder head or button head socket cap screws with heads no higher that 0.032".

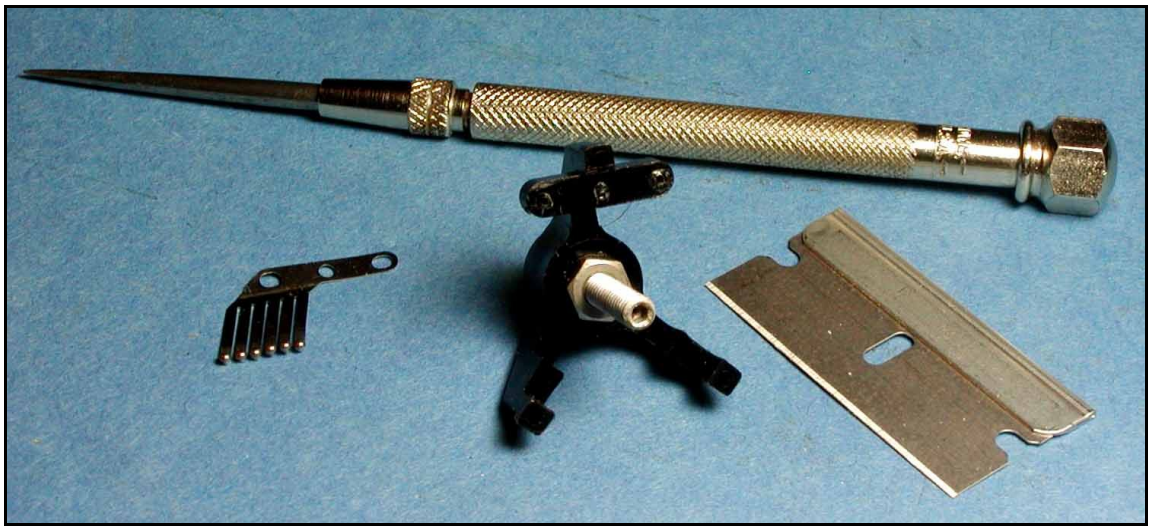
Contact Finger Repair and Reattachment

To begin the repair, remove the contact fingers from the plastic spider, if it has not fallen off already. This is easiest to do by clamping the spider in a small drill vise and using a single edged razor blade to cut off the plastic nubs holding the metal piece. Slide the razor blade parallel with the top surface of the metal piece slicing off the nubs. Do not cut the large foot nearby. Once the contacts are removed, clean off any bits of plastic that

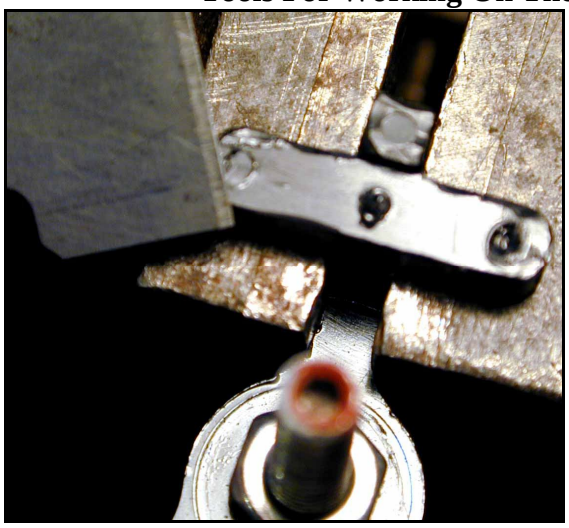


Cut Nubs To Remove Fingers From Spider and Clean Up Metal Finger Piece

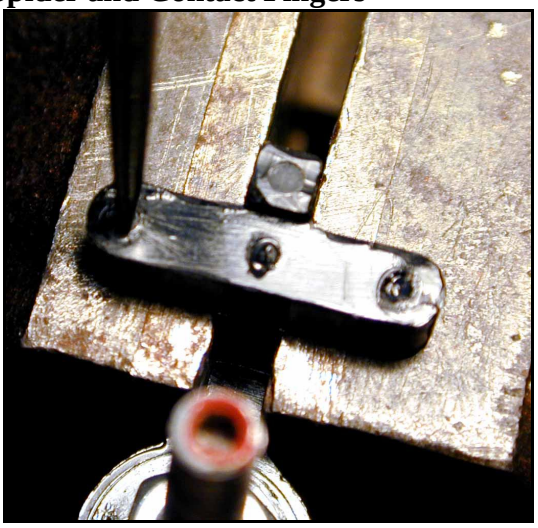
remain in the holes with the razor blade and a scribe. Then clean the area on the spider where the contact finger piece was attached. Use the razor blade to remove any plastic left over from the 3 original joints. Make the area smooth and flat when finished.



Tools For Working On The Spider and Contact Fingers

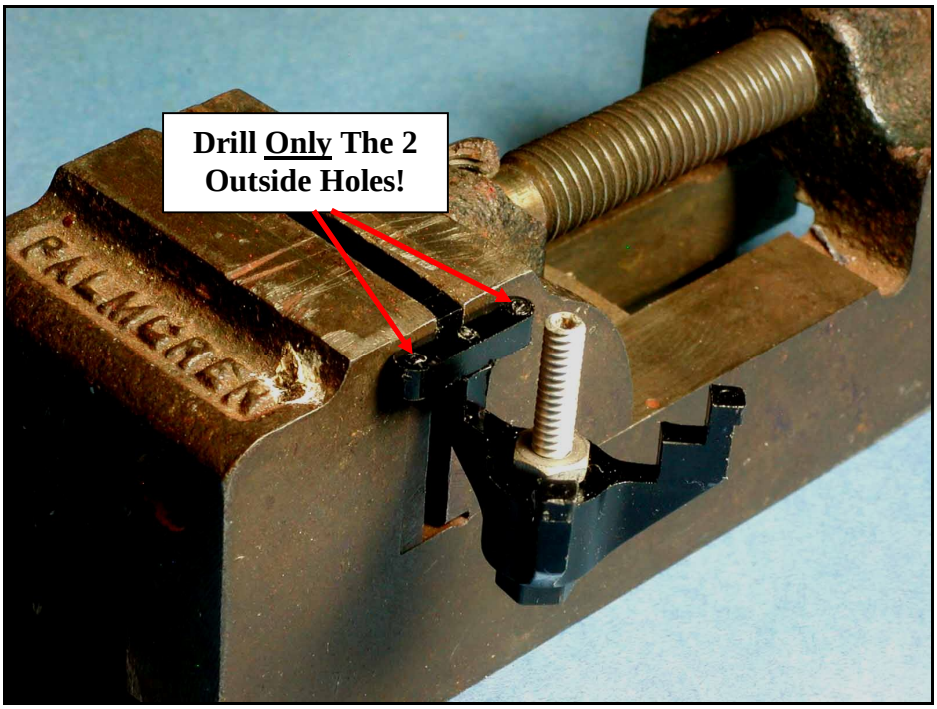


Clean Off Spider Mounting Area



Make Dimples With Scribe

Next carefully determine the centers of the two plastic pins that once held each end of the contact set. A shadow of the original pins should be visible in the plastic molding. Use a scribe to make a dent in the middle of each of the two end pin shadows to serve as centering dimples for the drill. Clamp the spider in the drill vise as shown above to provide support when pressing to make the dents. The dimples will guide the drill to the correct locations like center punch marks. Clamp the spider in the vise again as shown in

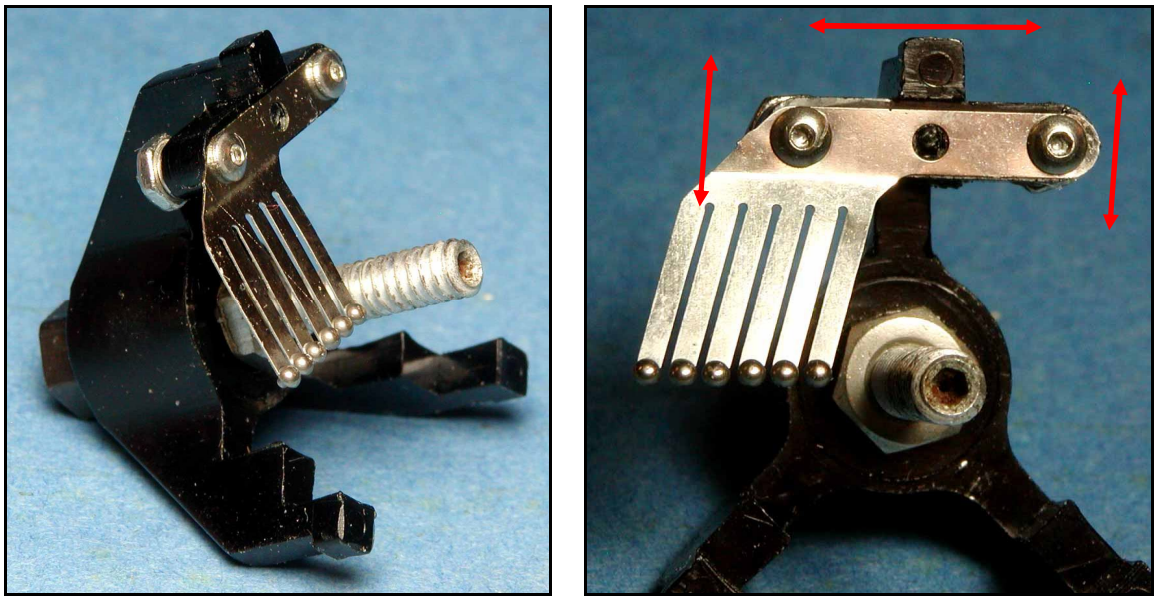


Spider Clamped In Vise Ready For Drilling

this figure so the drill will miss the jaws of the vise. Make sure the spider adjustment screw is parallel to the side of the drill vise. We really do want to drill the holes nice and straight!

Use a drill press to drill the 2 mounting holes in the spider with a #53 drill (0.0595") if available. If a #53 is not available, a 1/16 drill (0.0625") can be used in a pinch but a smaller hole is better. A number 80 screw has a nominal diameter of 0.060", but typically measures 0.057-0.058". Also, the wobble of most drill press chucks will make the hole just a little larger than the drill size. The two end holes in the metal contact finger set are quite a bit larger than the 0-80 screws so the exact position of the fingers can be adjusted by sliding the metal piece around as it is tightened. We don't need an oversized hole in the plastic piece as well. Deburr the holes gently with an oversized drill about 1/8 of an inch in diameter taking care not to remove too much plastic material around the holes.

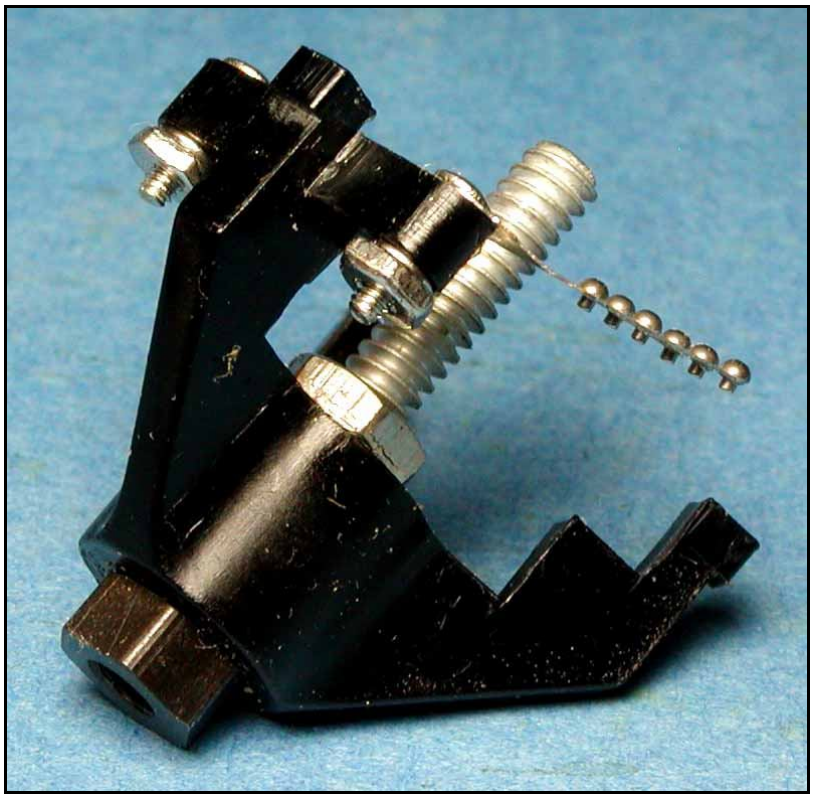
After the spider has been drilled, use two 1/4-inch 0-80 screws, lock washers and nuts to attach the contact finger set to the spider. Use heads with the lowest possible profile. We have been successful using screw heads 0.032" or lower. Install the screws with the heads holding the metal piece and the lock washers and nuts on the plastic spider side as shown in the photos below. Tighten the screws only gently at this time. Then position the



Attaching and Positioning the Contact Fingers on the Plastic Spider

metal finger set so that the center hole is exactly over the shadow of the original center mounting pin in the plastic piece. Turn the finger set back and forth until the top edge is exactly parallel with the edge of the plastic piece. Tighten the 2 screws a little at a time making sure the metal finger set stays aligned as described until they cannot be tightened any further with a small screwdriver or Allen key and a short needle-nosed pliers to hold the nuts.

Examine the 6 metal fingers after the assembly is complete and bend the metal fingers slightly until the contact balls extend in a straight line, perpendicular with the adjustment screw in the center of the plastic spider. The goal is to make all the contacts touch the circuit board with the circular traces at the same time as the spider is screwed into the board.



Bend the Individual Contact Fingers To Make a Straight Line Perpendicular to the Adjustment Screw In The Center

Band Switch Assembly and Adjustment

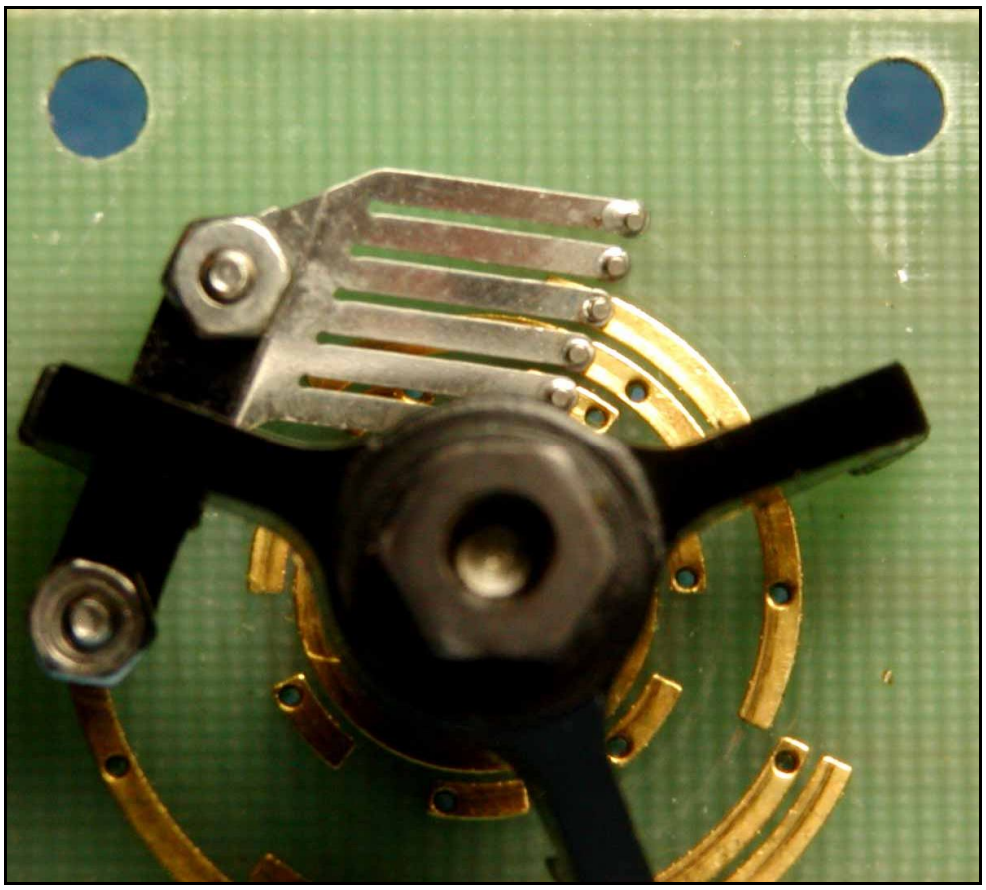
Slowly and gently turn the adjustment screw into the contact circuit board. Make sure all the contact finger balls touch the circuit board at about the same time. The spider is mounted to the adjustment screw only loosely and has a few 10s of mils of axial free play. The center-mounting hole is also slightly oversized to allow the spider to nest in the slots at the end of the dial drum. When everything is reassembled, the dial drum will axially push on the plastic spider with just a little bit of spring force, causing the spider to ride on the metal nut on the adjustment screw seen in the photo above. Therefore to see the final position of the contacts on the circuit board traces, push the plastic spider gently and evenly toward the circuit board when evaluation clearances. The three feet of the spider should be very close to the circuit board, but not quite touch. Because the spider will be nested in the dial drum, all 3 feet will be evenly pushed toward the circuit board, and no one foot will be pushed out further than the others.

As a very good starting point, set the adjustment screw to have the same number of threads exposed as there were before the switch was disassembled, and gently set the lock nut. Push the spider evenly toward the circuit board. Look between the circuit board and the spider feet. All the feet should just barely miss touching the circuit board, but one or another foot may touch if the spider is not pushed evenly. Next, make sure the heads of the new 0-80 screws miss the circuit board traces. The height of the heads is 32 mils and there should be about another 32 mils of space between the heads and the circuit board when the spider is pushed evenly toward the board. If the screw heads touch, back off

the adjustment screw until there is about 1 head-thickness of clearance as the spider is pushed in evenly.

Contact Finger Alignment With Traces

Next, check that the contact balls at the end of the metal fingers will slide over the middle of the gold plated traces on the circuit board. Again, alignment should be checked with gentle, even pressure of the spider toward the circuit board.

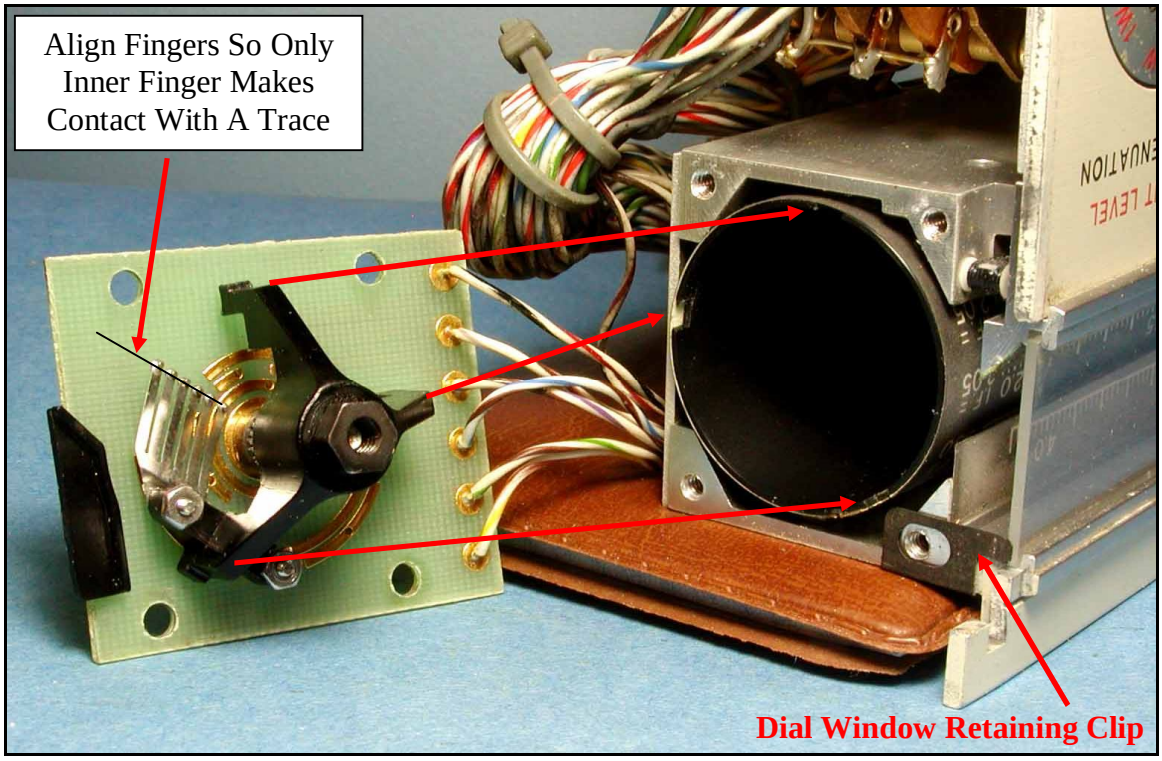


Proper Contact Finger Alignment During Reassembly
Note the scrub marks on the traces show the original factory contact finger alignment was not quite perfect on this spectrum analyzer.

If the fingers are not aligned well with the circuit board traces, remove the spider, loosen the screws holding the fingers, reposition the fingers to improve alignment and try again. The holes in the metal finger piece are large enough to provide more adjustment range than needed. Reassemble the switch, adjust spacing and check finger alignment. Make sure the metal finger piece is firmly screwed to the spider when finished, and be sure to firmly set the lock nut on the adjustment screw. I prefer to use just a little dab of acrylic paint as a locking agent on the screws to make sure they don't vibrate loose. DO NOT use red (high strength) Lock-Tite. It will make the unit very difficult or impossible to fix in the future. Finally, clean the switch contacts and traces with isopropyl alcohol before final assembly, and then use a drop or 2 of lubricating contact cleaner before mounting.

Frequency Band Switch Replacement and Test

The frequency band switch can now be mounted into the Tuning Head Assembly. The photo below shows how the spider should be aligned with the slots in the dial drum if the dial is set to the 0.01-2.05 GHz band. Position the dial window retaining clip as shown before screwing the switch into place or it can be slipped in after the other 3 screws are loosely fitted. The feet of the plastic spider nest in 3 slots in the frequency dial drum. Gently ease the switch into the slots and reinstall the screws, with the original flat washers and lock washers.



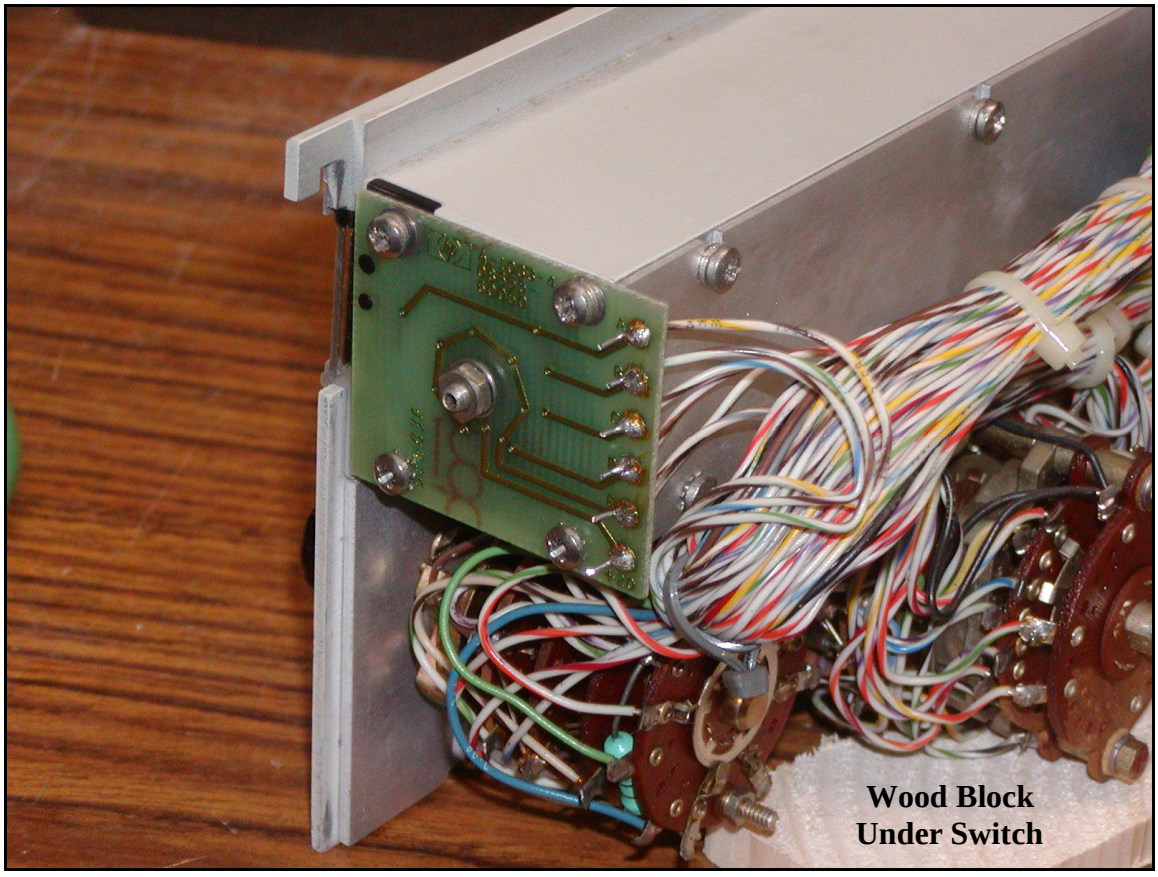
Frequency Band Switch Replacement Into Tuning Head Assembly

Test The Repaired Band Switch

Once the switch has been replaced in the tuning head assembly, turn the front panel right side up and support the rear of the SCAN WIDTH switch with a thin spacer. Test the switch mechanically by incrementing the BAND paddle on the front panel through the various positions, going both up and down. If the mechanical action of the switch feels stiff or does not increment through the bands smoothly, the switch may have been assembled with the spider spaced too far from the circuit board assembly, pushing back on the frequency dial drum too much and causing the band change mechanism to bind. Sometimes the legs of the spider will not seat completely down in the slots in the frequency dial drum or get caught on the drum-covering layer. This will also push back the dial drum causing the band change mechanism to bind. Finally, the action may also feel stiff if the spider is spaced too close to the circuit board causing it to scrape against the circuit board with the contact traces.

In any case, if the BAND paddle does not function smoothly, take the switch apart again and make sure the legs of the spider seat fully in the slots of the drum. Check the spider spacing and perhaps try a different setting. Often, if the spider is spaced too far from the circuit board, the mechanical band switching drive assembly will bind. Of the 4 analyzers we have repaired, 2 switches had to be taken out a second time to get the spider legs to seat properly and/or to get the spacing right. Take your time, and get it right.

It is also possible to adjust the switch spacing once it is assembled to the dial drum assembly. This requires an Allen wrench and ¼ inch box wrench. Use the box wrench to release the lock nut and turn the adjustment screw in **gently** as far as it will go; then back it out again until the band change paddle works easily. Tighten the lock nut **gently** to keep the setting from moving. This assembly and adjustment is most difficult part of whole job.



Band Switch With Small Solid Wire Stubs to Facilitate Testing

The proper electrical function of the switch is shown in the truth table below. If you are alone, to make testing easier, it is useful to solder small stubs of solid wire to the band switch connection pads on the circuit board. If you have a helper, it's easy to have one person hold the probes on the switch as the other person changes bands. Connect one lead from an ohmmeter to the common connection labeled +20 at the bottom of the

circuit board. Then connect the other lead from the ohmmeter to the various other contacts labeled A, B, C, D, and E.

Frequency Band Switch Truth Table

Frequency Band - GHz	Harmonic Number	Band Code ABCDE	Frequency Band - GHz	Harmonic Number	Band Code ABCDE
1.50-3.55	N = 1-*	**00010**	8.23-14.35	N = 3+	**01001**
2.60-4.65	N = 1+*	**00011**	6.19-14.35	N = 4-	**11000**
0.01-2.05	N = 1-	**00000**	10.29-18.45	N = 4+	**11001**
4.11-6.15	N = 1+	**00001**	10.31-22.55	N = 6-	**00100**
2.07-6.15	N = 2-	**10000**	14.41-26.65	N = 6+	**00101**
6.17-10.25	N = 2+	**10001**	18.55-38.95	N = 10-	**00110**
4.13-10.25	N = 3-	**01000**	22.65-43.05	N = 10+	**00111**

* Band uses 550 MHz first IF Band code 0 = open circuit. Band code 1 = connected.

Increment the BAND paddle on the front panel through the various positions and check that the connections in the truth table are made correctly. The band map can be translated into an action plan as follows:

Bit E connects to +20 (common) for every (+) band, and is disconnected for every (-) band. That is, it will alternate with every band change.

Bit D connects to +20 for both the 550 MHz IF bands and both the N=10 bands, and is disconnected for all other bands.

Bit C connects to +20 for only bands N=6 and N=10

Bit B connects to +20 for only bands N=3 and N=4

Bit A connects to +20 for only bands N=2 and N=4

If some connections are unexpectedly open, the switch fingers may be misaligned, or the spider spacing may be too large. If more connections are made than are shown in the truth table, the spider may be too close to the circuit board causing the screw heads to scrape, or the contact fingers may be misaligned. In either case, remove the switch and carefully observe the contact alignment and the spider spacing, correct the problem and try again. Of the 4 analyzers we have repaired, we have never had a contact finger alignment problem after carefully adjusting the fingers with the switch open. Work slowly and carefully, and the switch will probably work on the first try.

Analyzer Assembly

After the band switch works on the front panel, carefully examine the many other switches for problems. If any were intermittent before the repair was started, clean and lubricate them now when the front panel is dismounted. I prefer to use only a small

amount of lubricating contact cleaner applied sparingly directly to the contacts, rather than soaking the entire switch. The small slide switches seem the give the most trouble.

Replace the front panel into the RF Section by reversing the instructions on page 9 and 8. Replace the covers on the RF section, and then mate the RF section to the IF section by reversing the instructions on page 5 and 4. Finally slide the RF and IF section pair back into the display section. Congratulations! You should now have a spectrum analyzer that works on all bands again!

Web Page Posting

This article is available to download in electronic form on the MGEF W2SZ/1 VHF/UHF Contesting Multi-op web page: http://www.mgef.org/links.htm under the heading "RELATED LINKS", and subheading "Reference materials". The Power Point presentation given at the conference will also be available at this site.

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HP 8555A Manual

A scan of the complete original HP 8555A Spectrum Analyzer RF Section operating and service manual can be down loaded from the Boat Anchor Manual Archive (or it's mirrors) for example at: http://bama.edebris.com/manuals/

List Of Parts & Tools To Repair The HP-8555A Band Switch

NOTE: 0-80 screws may also be available at local hobby and model stores.

1. 4 Tiny 0-80 Screws 0.250" Long, with lowest profile head possible. Low profile binder head will work or even flat head screws. A quantity of 4 is given so one or two can be lost during the repair. Button head socket cap screws available from McMaster-Carr number 92949A054 - $7.99 for pack of 50. Hex drive key: 0.035" Head height 0.032". Binder head screws also have head 0.032" high, stock number: 91793A055 with a straight slot drive. Cost = $13.34 per pack of 100.
2. 4 Hex Nuts 0-80 thread. Can use McMaster Carr 90730A001 undersized nut at a cost of $6.82 per pkg of 50, or stock no. 91841A115 at $8.16 per pkg. of 100.
3. 4 Split Ring Lock Washers for 0 screw size. McMaster Carr # 92146A510 priced at $4.07 per pgk of 100
4. Tiny Screw Driver to fit 0-80 repair screws chosen above, or hex key if low profile button socket cap screws are chosen. (My screws used a 0.035" hex key). A 0.035" Allen key wrench from McMaster-Carr is number 6493A62 for $0.71. For straight slot screws, conventional "jewelers screwdrivers" should work well.
5. Small Needle-nose Pliers to manipulate the tiny screws and hold tiny nuts.
6. #53 Drill – 0.0595" diameter but 1/16" drill can be used if not available. Note: The number 0 screws are listed to have an outside dimension of 0.060" but I have measured them to actually be about 0.058 inches, so a number 53 drill works well especially since the wobble of the drill chuck will make a slightly larger hole.
7. Volt-Ohmmeter and Test Leads
8. #2 Posidrive Screwdriver for covers (Phillips can be used if not available)
9. #2 Phillips Screwdriver, for screws holding switch to tuning head assembly
10. Small Flat Blade Screwdriver
11. Single Edged Razor Blade or "Exacto" Hobby Knife
12. Sharp Pointed Scribe
13. Drill Press
14. Small drill press vise.
15. 1/16" (or 0.0625") Hex Allen Key (for band switch spider screw)
16. 1/4-inch ignition wrench (hex box end preferred) (for spider screw lock nut)
17. Isopropyl Alcohol for cleaning switch contacts. 91% available at Walmart.
18. Contact Cleaner/Lubricant, for band switch and also other front panel switches "Jiffy Bath" contact cleaner is available from GC Electronics, Part no 19-638

Appendix A

BAND SWITCH REPAIR OF THE 8555A SPECTRUM ANALYZER RF SECTION

By Peter K. Blair, G3LTF

Found by Buck Calabro, KC2HIZ -- The mighty Google turned this up at:
http://list-serv.davidv.net/pipermail/moon-net_list-serv.davidv.net/2006-January/003450.html
It was actually first posted on "The Moonbounceboard" by G3LTF on 11/2/2004.

Friends, I have put this together as a set of repair instructions because anyone with an HP141 and the 8555A RF unit will possibly encounter the problem. File it away! Thank you very much to Jeff, WA3ZKR and Peter, I5CTE for pointing me in the right direction on this. It was not too difficult in fact, and you don't need a handbook. The problem was that the spring wiper contact, which connects the various encoder lines, had come adrift from the rotating arm. I refixed it by carefully drilling the arm and using two 50 thou. diameter screws (12BA), 0.25" long to secure the spring. It is better to use countersunk screws and slightly countersink the holes drilled in the arm so as to have a low profile fixing. I put two nuts on the far side to be sure they would not come loose.

You get to the rotating arm by removing the protective covers, top and bottom and then the screws at the side and bottom holding the front panel. This then lifts out as a sub-assembly and its cable can be unplugged. Remove the 4 screws at the right hand end of the band switch assembly; watch out for a small leaf spring in the lower left hand corner, which will drop out at this point. The plate held by these screws is the contact assembly. Release the central nut and you can then remove the rotating arm. Drill 2 holes at the ends of the arm and re-fix the spring fingers. Refit the rotating arm and adjust the tension to give good contacts and check this with a VOM. Reassemble into the band switch making sure that the rotating arm engages in the correct slots in the end of the drum.

Mine worked perfectly again after this treatment. NOTE... Before the band switch failed completely I was also experiencing an occasional instability of the display, a frequency jitter... this has now gone and I guess it was the partial connection of the spring fingers before they finally fell off!

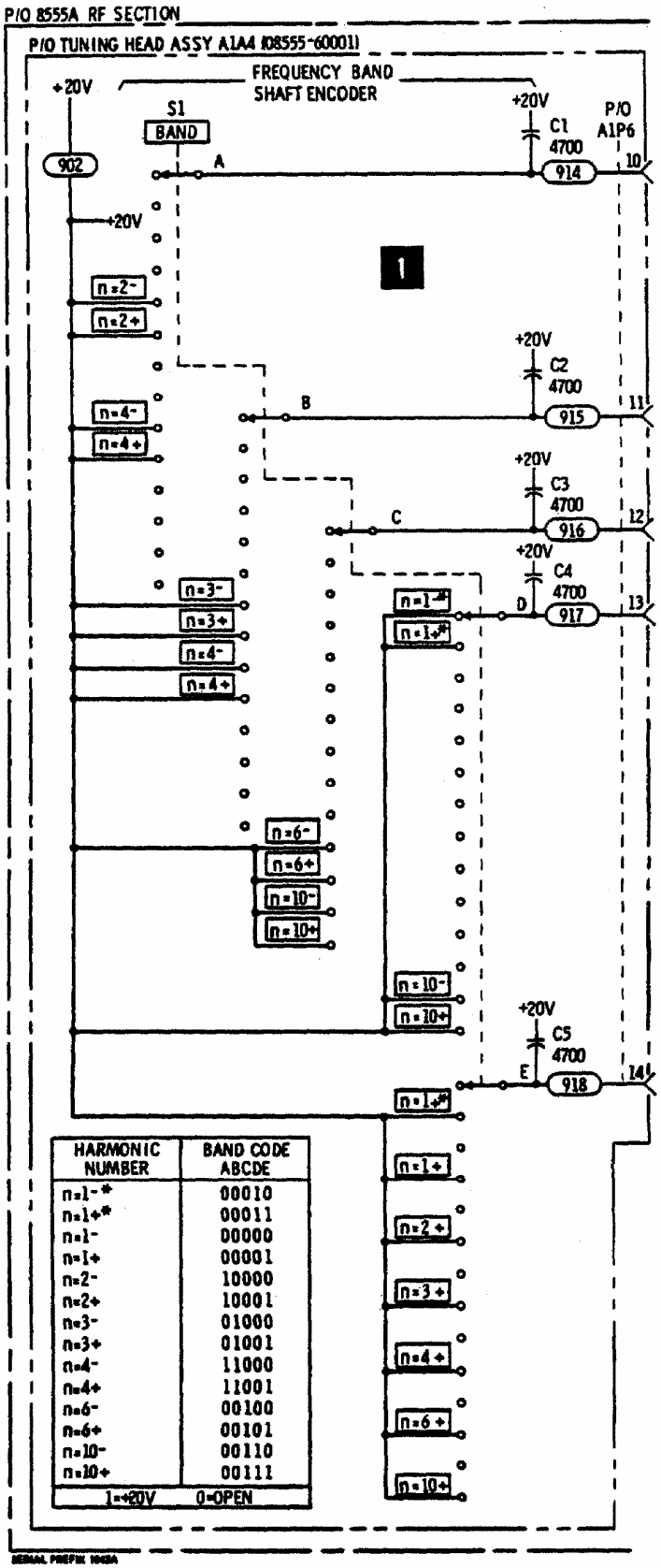
73 and GL, Peter Blair, G3LTF, Woodleigh, Upper Wyke, St. Mary Bourne, Andover, SP11 6EA, UK Email as of 11/09 is: g3ltf@btinternet.com

Reformatted and slightly edited by R. L. Frey – WA2AAU 11/18/2009

Appendix B

Original HP 8555A Band Switch Schematic

Newer Revision With Bypass Capacitors



P/O Figure 8-58. Band Code Switch Logic, Schematic Diagram (CHANGE 14)