

# Grounding & Contact Cleaning Recommendations

(General Guidance & S-Line Specific, 01/07/2015)

## Grounding

Let's look at some fundamentals first. We assume you are here looking for guidance when maintaining your Collins, so that will be the perspective.

From both a DC and particularly an RF perspective, just because some component is mechanically connected to ground does not mean it is grounded in the technically correct sense that we are looking for.

There are several culprits to be aware of. The first is related to the use of dissimilar metals and this is almost impossible to eliminate, even if you contemplate hardware changes.

### DC Ground

Every metal has a characteristic barrier work function that describes the energy necessary to cause an electron to leave the surface of that metal. This phenomenon was not well understood in the time period prior to the mid-1960s. Radios built prior to this time period – or designed prior to that date range are going to have problems related to this characteristic. In fact, when you place dissimilar metals against each other, there is what amounts to a small battery created and a current flows in this localized "Battery". This current flow then promotes metallurgical changes and corrosion. Soon the surfaces involved have interface problems that increase the originally low DC contact resistance.

### RF Ground

In addition to this DC effect, there are RF factors that must be accounted for. These do not change much with time, but you just need to understand them. The big culprit is lead length. What looks like a ground at DC may, in fact, be an inductor. This lead inductance is a function of the lead length and configuration of the grounding component (internal construction) and has increasing impact as you go up in frequency. For instance, what looks electrically like a RF ground at 3 MHz, may in fact be a poor ground at some very much higher frequency where you would like the component to work the best.

An example of non-intuitive RF grounding behavior is the following: Often if you have a node bypassed with a 0.01 uF disk ceramic for instance, you can improve the "ground" at RF (and at higher frequencies) by replacing it with a 0.005 uF cap of much smaller construction, or just adding that cap in parallel. What is important is that the internal structure of the capacitor – in the case of the 0.005 uF – has smaller parasitic inductance, and works better at say 100 MHz where you might be hunting for a parasitic oscillation fix. Another way you should look at this is to assume both the .005uF and .01uF capacitors have the same equivalent lead inductance of .5nH. In this case, the .005uF cap will be series resonant at 100MHz, resulting in a better RF ground than the .01uF cap. For this reason, it is important to know the self-resonant frequency of capacitors intended for RF bypass use. I have seen these effects over and over again.

Now onward to some very pragmatic specific aspects

It is recommended, and just good practice, to loosen, move and then retighten ALL of the ground screws in the radio. After 50 years, many of those grounds are no longer adequate electrical grounds. You should do this once in your cycle of maintenance of any piece of Collins gear.

As you do this, do one at a time and use a pattern to keep track of where you are so that you do not miss, or leave a loose one, behind you.

This rework treatment will make a huge difference in the performance and alignment of the radio, particularly the transmitter sections. In addition, it will tend to make the radio quieter, from a noise floor standpoint.

There is another benefit. The potential IMD and or birdie issues will go down. Some of those ground contacts can actually turn into semi-diodes and become non-linear sources of IMD products. Those of you familiar with mountain top IMD analysis and shipboard IMD interference will testify to how onerous this issue can become.

You should pay particular attention to tube socket ground points where shielded cable terminates and also to any shield can or cover like the band switch covers on the KWM-2 and other S-Line equipment. You will be amazed at how this stabilizes your rig during alignment. When you tighten the grounds on the RF shield covers on those band switches, easy does it and do not overtighten which can strip threads or distort the covers.

There is one other ground issue (at least) that is well worth noting here. Be sure to clean ALL of the running surfaces of those slug racks, and then do not lubricate them except at the end bearing in the back. Oil and dirt on the BeCu (beryllium copper) running bands is a RF alignment and stability problem waiting to happen. We see so many rigs where someone along the way has decided that those running bands and their matting surfaces need lubrication.... BAD!!!

If you analyze the motion involved, there is no relative movement on those surfaces. They just flex in and out of contact and that contact stabilizes and provides the RF ground path for the entire slug rack along with the slugs and all that stray capacitance.

### **Switch Contact Cleaning**

Before getting into the actual cleaning advice here, just a practical suggestion. Nothing cleans those switches better than good continuous use. Make sure you are exercising those switches through their entire range every so often. Don't just madly switch them back and forth though. Give the contacts time to settle, and the detents a chance to seat. Steady rotation is good. So many of our radios tend to hang out in one mode, or on one or two bands that, if we are careless, years go by and switches never see their entire range.

The following cleaning advice is a compilation of a number of threads and sources of advice – both on and off of our reflector. It has been scrubbed by engineering background folks and also contains a lot of information that originated with Collins and Dennis Brothers of Collins Radio. Some of it will be viewed by some as controversial. This is a subject that has many perspectives, but we have done our best to sort wheat from chaff and give you the best advice here that we can.

Note here for those of you who are new: Much of this advice comes from Dennis Brothers of Collins Radio. For the record, and for those reading this on the reflector who are neophytes, Dennis Brothers runs the only remaining Rockwell Collins authorized repair facility dealing with amateur radios, and he is certified with, and used by, the U.S. Government for Collins equipment. For many many years....I am guessing more than 20, he ran the Collins Radio internal RMR and production line repair facility in Cedar Rapids at Main Plant. He was responsible for fixing line radios that did not meet spec, or returns and factory modifications. He has supported our efforts and was involved with the production of the Hi Res videos on Collins rig maintenance. Dennis is THE most experienced Collins repair guy alive and knows your S-Line like the back of his hand. Very nice guy. Very busy guy. He also runs a large wheat farm in northwestern Nebraska as well as running his repair facility.

There are two areas of a switch that need attention. The first and most critical are the contacts. The second is the detent arrangement at the front of the switch that keeps the switch perfectly aligned at each point of contact. Both are important. If the switch feels mushy when you turn it and you do not feel the detent pop into position, then there is a problem. It is usually dried lubricant and in this case can be carefully

cleaned out and re-lubricated. It can also be a much worn detent assembly and there is not a whole lot you can do about that - other than replace it.

When cleaning the detents, use a good commercial tight wrapped or foam swab (similar to a Q-Tip) and a strong solvent like lacquer thinner. Get all of that old grease out of there. Be careful not to run that solvent down into the through-panel bushing or shaft area. Also be careful not to get that lacquer thinner on the paint or the dial. Then, lubricate the detent ball and assembly sparingly with a good lithium based grease like MAC 1066 (recommended by Dennis.) I also run a very small amount of light high grade gun oil down the shaft bearing and work it in. Less is better, but some will make a huge difference in control smoothness. Some bearing/shaft assemblies are made of dissimilar metals and will corrode over time. This will free up those shafts and prevent further degradation.

OK, the switch now acts nice and "lively". On to the contacts.

There are two approaches here that are recommended. Both involve carefully putting cleaner right where you want it and NOT spraying it around. That can lead to future problems.

#### The Deoxit approach

If you are attacking a problem area specifically, then I like to use Deoxit D100 cleaner. This is available from good electronic supply houses and it works well and does not leave residue. There is some lubricant residue left by the older D5 cleaner. This cleaner should be applied with a wettable probe or a needle applicator so you can control the amount that you apply. It should be applied to the wiper tab on the switch wafers one at a time and the switch should be promptly rotated back and forth a number of times through its entire range. For stubborn or more severe cases, a small amount applied to as many of the pincer segments as possible also helps - followed by the rotation. The intent is to make sure you carry the cleaner through to each one of the contacts. Then, blow out the switch after it has time to dry to make sure all liquid is gone. Use low pressure (like 40 psi or less of CLEAN compressed air or a "Dust-Off" kind of non-residue product.) Do not power up the radio until you know the contacts are dry. Contacts carrying higher currents can carbonize the cleaner if still wet and leave a worse issue than you started with.

You are NOT trying to take the tarnish off of those contacts.

There are a couple of things that you should know about switch contacts and particularly Collins' later switch contacts such as those on the S-Line.

First, that tarnish is Silver Sulfide and not an oxide. That "tarnish" is actually conductive and not part of your contact problem unless a very severe environment has been encountered. More on that later. What you are trying to remove is the buildup of the unavoidable environmental dirt and crud that flies around our world. Some places are worse than others.

Trying to get all that tarnish off is both a fool's errand (Yes, I know it looks really great afterwards) but in the process you are doing two things that should be avoided. First, the less you monkey around with the contacts mechanically, the better off you and the switch will be. All of us have broken a wafer at times, and they are not fun to replace. Secondly - and just as or more important - that tarnish is a Silver Sulfide and has used up some of the silver plating and passivated the surface. It is a pretty self-limiting process. If you shine it all up some way, and take that Silver that is in the tarnish away, it will just tarnish again and then you lose more of the Silver plating. "Nuff said" about that.

I will specifically say here that occasionally someone will recommend Tarn X or some other acidic bath type "tarnish remover" as a way of cleaning contacts. DO NOT EVEN THINK ABOUT IT. First read the above, and then know that that stuff has OSHA identified carcinogens in it, has hazard warnings about the time

limit it can be on, its damage to other metals like Collins stainless steel, and warnings that it can attack organics – like switch wafer. Really bad stuff.

There are documented cases of where the Tarn X has damaged the silver surface itself.

### The Solvent Approach to contact cleaning

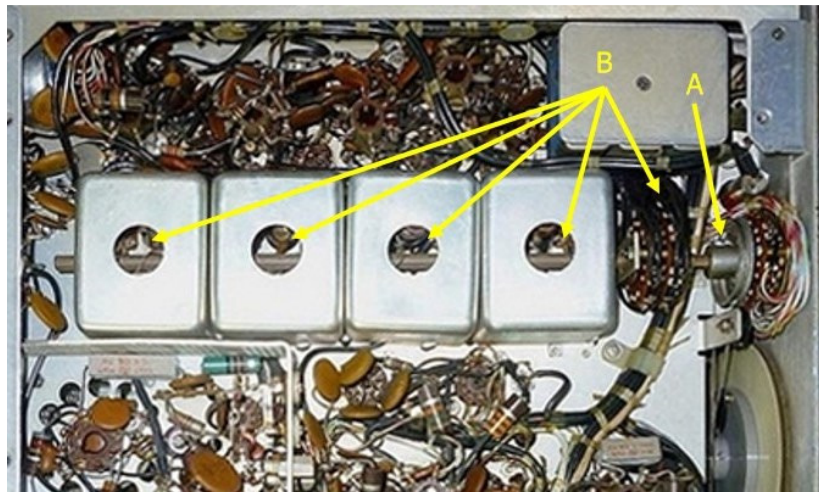
Dennis Brothers recommends and uses the following method for his contact cleaning – be it one or one hundred.

He is not bothered by the tarnish and does not try and remove it. He uses a solvent mix of very high purity (<2% water Technical Grade) Isopropyl Alcohol mixed 50/50 with Acetone. This mix produces a liquid solvent that rejects water and evaporates quickly leaving no damage and no residue.

It is applied from a solvent-safe chemical solvent bottle that is flexible and has a thin, long and pointed spout on it so the solvent can be accurately applied where wanted and in small amounts. He then quickly but carefully runs the switch all the way through its range to spread and deploy the solvent. He adds that “due to the evaporation rate, he sometimes has to do the cleaning/cycling three times”. He also then blows out the area with clean air.

This Acetone/Alcohol mix is the only contact cleaner he uses. He says he does not have any negative issues with Deoxit, but just prefers the less intense solvent treatment and it works reliably and holds with time.

All of us agree on a general approach to all cleaning where you start with the mildest treatment that works. Only if it doesn't work should you work your way up to stronger treatments with more potential negative side effects.



### **Removing that S-Line band switch shaft**

When working on an S-Line product, the day will come – either for cleaning or for maintenance – when you need to remove the band switch covers. This is not as bad as it looks at first, but there are a couple of things to look out for.

Obviously, to remove the covers, you need to remove the band switch shaft. When cleaning, I like to remove the shaft quickly, then remove all the covers and replace the shaft so bad stuff does not happen, and so I can rotate the switch during effective cleaning.

There are some Hints and Kinks you must be aware of when removing this shaft.

Do not be intimidated. After you do it once, it will be simple. But you can get in real trouble. This wisdom came to me from *The Budster*, Bud Whiney, K7RMT years ago, and has served me well.

Some facts. The band switch shaft is made of some kind of fibrous phenolic. It can, and often does, take on a little warp over the years. You must watch for this and what it does to the switch wafers coming out, and particularly going back in. It is not a given that the shaft will just slide back in all those holes that used to be lined up. You must be careful coming out and watch for the shaft pushing the wafers around (this is usually pretty mild) and, particularly, watch for misalignment when sliding the shaft back in (at point B above). Being careless here can result in a broken wafer really fast. The shaft warp will happen - and you may need to reach in with needle nose pliers and carefully lift or push on the shaft end as it approaches a wafer hole.

Here is how to proceed. With the rig belly up and knobs towards the side, rotate the band switch to about the middle while watching the union where the shaft enters the coupling (point "A" above) Get the band switch positioned so you can get a Bristol wrench into both set screws without turning the shaft (Important). Now, before going any further, take a black felt tip marker and put a dot right in the middle top of the shaft right before the coupling and draw a line over the top of the shaft as close to the coupling as possible. This makes a "T". Now you can put that shaft right back where you found it and the warp if any will be right where it was and the set screws will strike the same spot. Do not ever overtighten those or you will have the devil's own time getting the shaft out the next time.

Before you go any further, take a look just forward of the coupling and you will see a circular dial cord pulley that has the plastic lined stainless cable running on it that goes to the upper band switch shaft area. NOTE: This assembly is going to come loose on the coupling end when you pull out the shaft (point "A" above). You do not want that pulley and wire to move towards the center of the radio and lose tension - which can release the wire. It is a pain in the butt to reposition and it is also another opportunity to get upper and lower switch wafers out of sync. I tie that drum and back over to the outside of the chassis and make sure it is captive in position for reassembly. You can wire it there with a small cord or a little safety wire.

Now that you have marked the shaft, and made sure that pulley is not going anywhere, go ahead and loosen the two Bristol screws and carefully slide the shaft out the back watching for warp. Putting the shaft back in is now just an easy matter of reversing the process, carefully reinserting the shaft one wafer at a time, and then tightening the screws.

Caution here: Even though you carefully marked that shaft and put it back where it belongs, after loosely tightening those screws, rock the band switch a little back and forth and carefully watch the contacts align with the pincers on the front wafers. You will notice that it is very critical about getting a particular pair where they both centered. Failure here will result in intermittent contacts and you will have a problem.

Be sure to remove the tape. Now, with the covers pulled and the shaft back in, you can work on those switches in more detail if need be. Put the tape back on before pulling the shaft again for cover replacement. Again, do not overtighten the screws on the covers or you will warp them or strip the screws. Before the covers go on, check for leads inside that the covers that may short to ground if they have been bent around in the cleaning process. There are a couple of close components in there.

The band switch is the biggest issue, along with the mode switch (from my experience), but treat them all and you will have a very reliable radio for years to come. Do the grounds at the same time, and you are all set.

## General Contact Cleaning

All of the above switch contact cleaning guidance also applies to the more general case of relay and other follower contacts. There is one note that should be adhered to though.

Relay contacts come in two types: Self-Cleaning (more modern and older) wiping relay contacts, and Contactor (higher power) contacts for larger equipment. None of these should be burnished or have that old contact file used on them. Only in the worst cases should a very mild contact file be used. Contacts are generally plated and that plating is not very thick. Filing takes away plating, and when you are out of plating, you are out of relay.

Relay contact cleaning is best done with Deoxit on a strip of clean (non-printed on) linen high quality business card stock. This stock is actually mildly abrasive, but relay contact friendly. Wet a strip in Deoxit and pull it through the contacts until you see almost no change in dirt removal. Then, switch to a dry strip and keep pulling dry strips through until they come out squeaky clean. You are then done and will have a reliable contact. Now, blow out the relay contacts with dry clean low pressure air to get out any possible lint. If you have used a good stock, there won't be any – but be safe.

Higher power Contactors do not generally need cleaning. They will, in many cases, look butt ugly and they are meant to be. Many contactors depend on striking an arc just as they make, in order to get very low resistance contacts. They look dirty and pitted and a little burned. Leave them alone. They are happy that way. Only when you have started getting contact issues that you can't resolve by cycling the contactor, should you resort to mild filing. Then, just take it slow and take the burrs off.

Until the next time, Have Fun with your Collins.

de The CCA Collins Gang – A combination of member contributions from the CCA Reflector, 2016  
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## **Suppliers/Comments**

### Alcohol

From Glen Zook, K9STH: At least when I was in college, the "pure" alcohol was called "lab 99". Since alcohol does absorb water, even the purest that can be bought is still going to have some water present. "Lab 99" is available from a number of different suppliers:

<https://www.healthykin.com/p-4898-99-isopropyl-alcohol.aspx?qclid=CNXI7LjFmMoCFYVAaQodlQcIwQ>

<http://www.zoro.com/techspray-isopropyl-alcohol-1-gal-998-1610-g4/i/G3552884/?qclid=COuAuOTFmMoCFQanaQodRTEJuQ&qclsrc=aw.ds>

And from Steve Berman: Forget all of this talk about "off the shelf" alcohol from CVS, Walgreens, Wal-Mart, drugstore of your choice, etc. That stuff has way too high a moisture content and too many impurities for lab/electronics use. What you need to purchase is alcohol rated as "technical grade." One such product is sold under the name of Puretronics. It's spec'd at being 99.9% ultra-pure anhydrous alcohol. Its attributes are: plastic safe, moderate evaporation rate, zero residue and ozone friendly. Stated applications of this product include cleaning contacts, circuit boards, connectors, flux removal and fiber optics cleaning. The product may be purchased at many industrial electronics parts houses. I procure mine from Kiesub Electronics in Las Vegas, NV. The product is manufactured by T. A. Emerald Industries in Irvine, CA.

I hope that this information can be of assistance to my fellow Collins enthusiasts.

Regards, Steve, N6HK

### High Quality Cotton Swabs

MG Chemicals makes good quality tightly spun swabs (double-ended). These are Pharmaceutical grade with nice long 6" birch wood shafts for getting deep into those band switches. Break off a shaft and use it to clean tube sockets after soaking with Deoxit. \$4.25 for 100 at my local electronics store. Use 'em all the time.

Dennis AE6C

### Needle Oilers and Cleaning Fluid Dispensers

Here is a link to Brownells. I buy the needle oilers for my office to place tiny drops of oil on micrometers, dial indicators, switch detents, etc. You can put anything you want in them to lube, clean etc.

<http://www.brownells.com/gunsmith-tools-supplies/shop-accessories-supplies/liquid-squeeze-bottles/needle-oiler-bottles-prod44434.aspx>

Ken  
KE7YD

### Potentiometer Cleaner (Deoxit Brand Fader Lube) and DL-100

Absolutely get the Red DL-100 with the needle applicator. Also get the Deoxit Green stuff called "Fader Lube" for the potentiometers. The green works on the pots like the red does on the switch contacts. Same needle applicator type.

Look on line and order foam lint-less swabs. Do not use Q-tips as you will leave lint behind and it will cause you all sorts of grief. Use the swabs with the red De-Ox-It and you will have clean, like-new switch contacts. I use the needle applicator to put a tiny few drops on the contacts and anywhere the contacts touch. I then switch the switch, and wipe the area clean with the lint-less swab. I repeat until clean. You will be amazed at how much junk you will get off of all of the surfaces.

73  
Gene K1NR

### More DL100 Comments

I recommend DeOxit D100L in the needle point applicator bottle and pointy industrial Q-tip cotton swabs. Use the needle applicator to apply a little DeOxit to the Q-tip, rub the Q-tip on the switch wafer metal band (not the contacts themselves) and rotate the switch. Repeat this until the Q-tip comes back clean. I then finish it off with DeOxit Gold GL5. This contains the splatter that happens if you use the spray can and it's not as wasteful as using the spray can to wet a toothpick or Q-tip. The needle point containers may seem a bit expensive but a little goes a long way and it will last almost forever. This technique takes a little more time and patience but it keeps the DeOxit off the switch insulator. I have had 100% success on all my Collins and Drake switches.

de Peter Doherty  
W1UO