Quick Read Books™
just the right amount of information

Soldering 101

Tons of color photos!
Techniques to replace amp components!
Keep audio connectors quiet!
Tools you must have!
Resources!

By Ron Holmes, IEEE & Linda French Holmes
Soldering 101
About the author

Ron Holmes started soldering when he was 10. He built his first tube amplifier when he was 7. He started repairing amps and radios and building tube-based kits and a PA amp when he was junior in high school.

In 1997, he became a full member of IEEE (Institute of Electrical and Electronics Engineers, Inc.) Previously, he worked for the University of Iowa Department of Physics and Astronomy where he was on the team that created the Dynamics Explorer I which was launched into space in 1981.

Ron holds a lifetime First Class Radiotelephone FCC License and was a broadcast engineer in the United States Air Force and later in the San Francisco Bay Area.

He has been trained and certified for NASA High-Rel soldering work and inspection. He has had Class 100 clean-room experience. Ron has worked with vacuum chambers used for testing satellite instrumentation as well as doing PC board conformal coating.

As a consultant, he designed and fabricated the electronics for several commercial microphones, studio audio products such as precision preamplifiers, equalizer, processors and a CMOS drum counter. He is co-designer of the Holmes-Powell Headphone Amplifier which won the Golden Ear Award from Absolute Sound in 1999.

Currently, he designs and manufacturers his own products. He lives in Bakersfield with his wife Linda French Holmes close to their four grandchildren.

www.holmeseng.com
Please Note:

The use of lead solder is being banned in countries all over the world. This ban has been spear-headed by the European Union. It is called RoHS Compliance.

The lead bearing solder is being phased out of new equipment. The goal is to remove lead contamination from landfills.

Unfortunately, the new solder alloys need very high temperatures and are extremely fragile.

Do Not Use lead solder on any equipment marked “RoHS Compliant”.
**Tools of your own you need:**

- Fine tip soldering iron.
- Solder tip cleaning sponge.
- Wire cutters
- Wire strippers
- Tweezers or fine pliers
- Cleaning sponge (wet)
- Philips head screwdriver
- Small adjustable wrench
- Magnifying glass
- Emery board or 150 grit sandpaper
- White ink eraser, pink eraser
- 99% Isopropyl alcohol (get at pharmacy)
- Clean toothbrush
- Drinking straw
- Craft Knife
- Optional:
  - 1/2 inch nut driver
  - Small, inexpensive, hand-held VOM for electrical testing
    - Solder pump
    - Forceps.
My everyday set-up for Soldering
My most basic tools. These are essential. Note the soldering sponge for cleaning the tip after every use, wide braid for de-soldering and good Multicore solder.
Tin/Lead Solder is lead-bearing. Lead is dangerous to your health. Keep washing your hands to minimize your contact with it.

Don’t breath it.

Solder melts at 700 degrees F.

Don’t burn yourself!

Don’t flick a hot tinned wire towards your face or body.

Soldering is NOT for children.

Soldering is NOT for anyone impaired by a medical problem that affects their hands or their coordination or their ability to follow instructions.

Soldering is NOT for anyone impaired by alcohol or drugs.
Tinning: A soldering process absolutely necessary to prepare a wire AND a foil or terminal in order for the wire to be tack-soldered onto the copper foil of a PC board or, soldered to an eyelet or lug. Tin/lead solder has real tin in it hence the name. That’s the shiny part.

How to Tin: Wires and Foils are “tinned” by holding a clean solder pencil tip across the wire strands. Tease a tiny bit of solder into the center between the solder pencil tip and the wire to create a molten bridge. This will heat the strands of copper wire so that they will accept a thin coat of solder. This whole process should only take one second.

De-Soldering: The process of removing a soldered wire from a foil pad, eyelet, or terminal. Remember-molten solder flows towards heat.

How to De-Solder: Use solder wick. To remove a soldered wire, lay the solder wick copper braid across the soldered wire or terminal, then heat with the tip of your solder pencil. The solder wick contains flux and fine copper strands. When it’s heated, it will draw in the solder you want to remove. When the braid heats the joint, the solder is immediately wicked into the braid. The braid is between heat source and thing to be de-soldered.

SOLDERING SECRETS: Use a clean solder pencil tip, good quality solder, fast heat, fast feed and no movement until the solder joint cools. Solder flows towards heat!

SOLDERING GOALS: Your finished solder joints should look like shiny taffy.
Always keep the tip clean and tinned-after EVERY use and during storage!
Wrap wire strands tightly. Apply heat and tease the solder into the space between the wire and the tip. A heat bridge will form to heat the wires.
When tinning, your goal is a thin coat of solder to flow completely through and around the wire strands. When you’re done, you can treat it like solid wire. Once tinned, it will solder well to eyelets, lugs and terminals.
Know the 10 Solder Rules

1. Your solder pencil tip should remain clean and shiny. Clean it by feeding a little solder onto the tip surface, then wipe the tip on a sponge soaked in water. Buy a soldering sponge.

2. Use the least amount of solder pencil heat to give you a clean, shiny looking joint. *Don’t use a soldering gun less you intend to solder copper pipe or solder a wire to chassis surface.*

3. Solder is lead-bearing. Minimize your physical contact with it. Wash your hands with soap and water when you finish soldering. Also avoid breathing the smoke.

4. Solder melts at **700 degrees F**. Use caution and don’t burn yourself. Don’t flick a hot tinned wire towards your face or body. Hot solder will injure you. If you use a solder sucker—be careful. They spray molten solder when they work. I recommend using only braid—it is safer and actually cleans better. They also make 600 degree and 800 degree tips/irons. But, I think 700 is best overall.
5. Use fast heat and fast feed and make sure your lighting is very good so you can see what you’re doing. Work under a lighted magnifying glass if you can.

6. Do not move until the solder joint cools.

7. Inspect your finished soldering with a magnifying glass. Your soldering should not be dull, grayish, mottled or crystalline-looking. These bad solder joints are called “cold joints” and must be done over. You should NOT see thin brown rings around the wires as they exit the soldered area. These are called “flux joints”. You did NOT use enough heat. You have to do it over. Solder joint should look like a smooth, shiny volcano.

8. Use a 25 to 35 watt solder pencil. A simple solder pencil works fine.

9. Clean and re-tin the solder pencil tip after every solder joint. This keeps oxides and debris from becoming part of your next joint!

10. **Use only quality solder with rosin-core flux.** Use 60-40 (60% tin, 40% lead) or 63-37 (professional solder). Buy top brands. Do not EVER USE acid flux solder used for copper pipe, because it will corrode printed circuit boards and terminals. Many of the solders used in sound gear in early 50s were really bad.

**WARNING:** Doing it over is no fun. But if you **don’t** solder right, your finished product will fail!
10. **Use only quality solder with rosin-core flux.** Use 60-40 (60% tin, 40% lead) or 63-37 (professional solder). Buy top brands. Do not EVER USE acid flux solder used for copper pipe because it will corrode printed circuit boards and terminals and ruin them. Many of the solders used in sound gear in early 50s were really bad. You find round globs on old tube sockets that just cause endless intermittents. Wick all the old stuff off and do over. *What you see is what you hear!*

**WARNING:** Doing it over is no fun.
But if you don’t solder right, your finished product will fail!
**GOAL OF WIRE TINNING:** To prepare bare wire to be soldered. The flux inside the solder cleans the metal as the solder flows across the wires or the copper foil.

Use just enough solder to form a thin jacket that conforms to the shape of the stands. The wire strand outline should be clearly seen under the solder. If not, you’ve used too much solder so reheat the tinned wire and tap on the top of the table while it’s still hot. This will knock the extra solder off. This is called “tinning” and is absolutely essential to prepare a wire to be tack-soldered onto a PC board copper foil or lug or eyelet.

**To get the best solder joints,** you can use a pink bar eraser to clean the dull oxide off the component leads by rubbing away from the part gently. Shiny leads make good solder joints. Dirty wire or leads will make the solder joints weak.

In general, use the least amount of solder pencil heat that will give you a clean, shiny looking joint. A 25 to 35 watt solder pencil is recommended. First, strip the insulated wire to 1/4 inch exposed strands. Twist the wires so that they are tight. Next, tin the wires by holding a clean solder pencil tip parallel to the strands. Tease a tiny bit of solder into the center between the tip and the wire to create a molten bridge. Solder will flow across the wire or the foil. Use a small vise or weight to hold down wire so it won’t move while working.
Always use fast heat and feed steadily and make sure your lighting is good. Do not move until the solder joint cools. Work quickly. Too much heat can damage the components.

Inspect your work with a magnifying glass. Your soldering should not be dull, grayish, mottled or crystalline-looking. Bad solder joints are called “cold joints” and must be done over. You should NOT see thin brown rings around the wires as they exit the soldered area. These are called “flux joints”. You did NOT use enough heat. You have to do it over. No flux should be inside the solder joint.
Identify the PC pad you need to connect to: then use an abrasive emery board or a small piece of #150 sandpaper to remove any existing foil sealant material lying on the top of the copper foil. This is called “solder mask”. If the copper foil appears green or blue, this means it is covered with a protective epoxy coat which must be removed before soldering begins. You can only solder to metal—not epoxy.

Locate a running line of foil between the solder pads and remove an 1/8 inch area of the solder mask from the top of the foil. The copper will then be exposed. The solder mask has to be removed otherwise it won’t be able to make an electrical connection to the foil.

Next, strip a small area of solder mask with an abrasive material and then burnish the same area with an ink eraser to polish the copper and remove any residue. You can only solder to shiny, clean copper.
Take the solder pencil tip and tease a small amount of solder onto it. Lay the tip across the exposed copper. Tease a tiny bit of solder between the foil and the tip to create a heat bridge to heat the copper foil. When the foil is hot, the solder will melt and flow across any exposed area. This should only take one second. This “tins” the foil.

To tack the wire onto the PC foil, first make sure both the wire and the foil are tinned. Next, build up a small mound of solder onto the exposed copper foil by heating and adding a little solder.

Then, lay the wire to be soldered across the top of the exposed foil, laying parallel and in the center of the foil. Heat the top of the tinned wire and keep pressure on the wire against the foil. This will transfer the tip heat through the wire to the tinned foil underneath and melt it. This solder melts at 700 degrees F so use caution and don’t burn yourself. Don’t flick a hot tinned wire towards your face or body. The hot solder will injure you.
Solder is lead-bearing. You want to minimize physical contact with it. Wash your hands with soap and water when you finish soldering.

When de-soldering a foil pad or removing a wire from a jack, you will need to either use the solder wick (included) or a solder sucker pump (option). Solder wick is actually better and will leave the cleanest solder joint.

To remove a soldered wire, lay the solder wick across the soldered wire. Then heat it with the tip of the solder pencil. The solder wick contains flux and fine copper strands. When it’s heated, it will draw in the solder you want to remove. As the solder wick braid heats the joint, the solder is immediately wicked into the braid. It works amazingly well. Solder wicks are available from any electronic supply house.
To add a wire to a jack lug, make sure the wire is tinned. With small pliers, wrap the wire around the eyelet or lug for 360 degrees for a tight mechanical joint. Then, lay the solder pencil tip across the wire and tease a small amount of solder which will flow across the wire and also across the lug that the wire is wrapped around. Solder flows with heat and generally flows towards the heat. This is why you want to completely heat the joint you are soldering quickly. Many of the plastic parts are thermoplastic and will melt if heated too long. The melted “ding” carries conductive debris from tip. So-try not to nick plastic.

Always clean up after soldering:

After all soldering work is completed, I recommend scrubbing the components, joints and circuit board with 99% Isopropyl alcohol (not 70% or 91%-both leave a watery film behind) and a clean toothbrush. Always blow the board dry before the alcohol evaporates by blowing through a drinking straw. The goal is to remove the alcohol totally from the board by blowing it away. Or, use a compressor and blowgun. Caution: alcohol is highly flammable so keep it away from hot solder pencils, light bulbs and any open flames.
WHY CLEAN-UP? Oil from your fingers, melted solder flux and spilled coffee will create a noisy board. For the very best sound, you want a clean board free from any contaminants. **Repaired tube sockets need to be spotlessly clean to avoid arcing.** High voltage follows a conductive debris path or track like it was a wire. Then smoke then flames.
This is a turret terminal with soldered wires. This is what it looks like before I remove the leads.
Here you can see the solder braid held snugly between the turret body and the solder tip. This is the best way to draw the solder from the post.
Here the solder has been removed and the lead wires removed. The remaining wires are the post are NOT damaged. It is easy now to add wires and re-solder.
This photo shows a typical can capacitor with solder lugs. With care, these fragile terminals can have old leads removed to add new leads.
You can see the braid held snugly against the terminal just using pressure from the solder pencil. The heat transferred here will melt the lug solder and will be drawn into the braid.
Another photo showing the de-soldering operation.
Here the solder is removed from the lug eye and existing wires can be easily withdrawn from the eye and new leads attached.
This shows solder and leads removed from the lug eye. With care, the lugs will not be bent or damaged.
Here the leads are re-attached and formed through the eye and crimped. This is now ready for soldering.
The lug has now been re-soldered and should be shiny and smooth.
Here’s another view of the finished procedure. It is mechanically strong and quiet.
Photo shows a tag strip lug being un-soldered. The braid is held firmly against the surface of the lug for maximum heat transfer.
Another view showing the braid wicking molten solder from the lug and wrapped lead.
Photo shows an unbent, cleaned tag lug. This is the starting point for adding new wires to re-solder. These are fragile. The lug can be easily broken so use care and patience.
This shows stranded wire waiting to be tinned so it can be attached to the lug.
This shows the wire after tinning. Notice you can see the outlines of the strands under the solder. You do NOT want more solder that this.
Tinned lead is bent and hooked through the lug to be crimped and soldered. Wires should always be mechanically tight before soldering. You get a stronger joint that way.
This shows tinned wire properly crimped onto the lug and waiting to be soldered.
Photo shows the wire after soldering.
Another view of the wire waiting to be soldered. Notice the shiny, flowing surface of the new solder joint.
This shows a switch lug being de-soldered. Use care not to overheat the eyelet. Your goal is to use just enough heat to wick all solder from the eyelet.
Another view. Using the wide braid makes it easier to remove volumes of solder more quickly. This results in less switch damage.
This shows the solder removed from the eyelet and the old wire is ready to be removed.
Done properly, the old wire will come loose very easily without pulling. Many terminals will bend easily so be careful.
This shows a tube socket with one red wire to be removed.
Here, the braid is held against the lug with just enough tip pressure to heat the lug. These lugs are very fragile and easily broken. Using a solder sucker to remove the solder from the tube lugs will generally break them.
Another view of the braid work. Notice the light pressure being applied to the terminal.
This shows the solder completely removed from the eyelet so that the wire can be withdrawn without strain.
This shows the removed wire and the clean lug. Solder braid will leave a terminal body looking like this ready to be soldered.
Another view of removed wire. Notice there are NO big globs of solder left on the lug. You want to remove ALL of the old solder with the braid. Otherwise, re-heated old solder will flow into the tube pin contact area and the tube will NOT fit into the socket anymore. If this happens or you find a tube pin contact in the socket that has solder inside it, you must twist the pin slightly to remove it through the top of the socket and withdraw the contact from the socket frame. Either use a new pin from a new tube socket or carefully use the braid to wick solder out of the old pin barrel. Then re-install the contact.
Typical solder eyelets used in vintage tube amps. Use wick across the eyelet flats to heat the eyelet and withdraw solder. This process will not fling solder or debris like a solder sucker will.
Another view.
This photo shows the solder removed from the eyelet so that the leads can be wiggled and withdrawn. Also note, the soldered eyelets around the board. They are shiny and smooth. This is how you want to end up after re-soldering.
Another view showing the cleaned eyelet and also showing a proper solder joint on the existing eyelet.
This is shielded audio wire. Strip back the plastic insulation to expose the braid shield. This must be done carefully so no braid strands are cut.
Push braid backwards, using safety pin or push pin. Gently separate the braid strands. The goal here is to work towards insulation leaving as many strands intact as possible.
Another view of the shield being un-braided.
After un-braiding shield, gently twist the strands together so they can be tinned as a single conductor.
View of the strands being tinned. The solder is slowly fed into the heat bridge space between the solder tip and the strands. Solder then will flow both directions away from the tip to fill voids. It is important to have the wires snugly twisted together before you tin.
Another view of the tinning.
A properly tinned braid. Notice you can see the individual strands underneath the solder coat. Beginners have a tendency to use too much solder. This will make the wire too stiff to bend.
View of power cord 16 gauge stranded wires. These are easy to do if done properly. Generally, strip one-half inch off each end of insulation. Then, re-twist snugly.
Another view of the leads stripped and twisted.
Close up view of the twisted leads. The goal is to wrap the strands tightly together in a spiral.
This shows using a heat bridge to heat the wire strands. Additional solder is slowly fed into this contact area as the solder flows into the strand voids.
Another view of the tinning operation.
The finished result. Notice how the tinning completely covers the exposed copper, but you can still see the individual strands. These leads will bend and solder easily into terminals and lugs.
This shows another type of shielded coax with the shield being unbraided. These are small strands. Do this gently.
This shows the unbraided strands before twisting and being tinned. The goal is not to break any strands.
Photo of braid after being twisted and tinned. Notice there is no visible copper braid strands. All are covered with solder. Also note you can distinguish the individual strands. The center conductor insulator melts easily because it is thermo-plastic. Keep heat away from the center insulator.
My Favorite Cleaning and Control Lubricating Items
BAD CONNECTORS CAUSE PROBLEMS

Your audio connectors are probably the most over looked part of your gear. BUT bad connectors cause a host of problems, especially when you’re using a high impedance microphone.

DIRTY, OXIDIZED CONNECTORS ARE THE WORST!

These result in loss of highs, loss of lows, random intermittent hum problems just to mention a few.

Your Cleaning Supplies:
- Isopropyl alcohol (99%)
- Erasers: pink or stick ink
- Tuner cleaner or contact preservative like Cramolin/Caig or a Shack equivalent.
- Cotton swaps or cotton balls
- Paper towels/old toothbrush/stiff cleaning brush
- Plastic drinking straw or Compressor and blowgun

If you clean your connectors once a year, they will STAY QUIET.

AND you will increase their life.

The air around us is highly corrosive to jacks, especially mic jacks.

Cleaning will seal out corrosion—especially if you live near salt water.

This cleaning technique can be used for any type of audio connector, even gold connectors.
Use this Cleaning Method:

Insert the jack or cable into the jig. Use the soft or stiff ink eraser to polish the 1/4 jack shaft and tip. These erasers will work for the non-abrasive cleaning of corrosion, grease and scuff marks. This method will NOT remove the plating, but will leave a bright shiny surface.
Next, wipe down all the metal surfaces with alcohol. All jack insulators must be really clean and have no solder residue because this residue is rosin flux and conductive to high-impedance signals! The alcohol can be applied with cotton swabs or cotton balls.

While the flux is soft, rub it off with a swab, clean toothbrush or stiff brush. Wipe it a second time with alcohol and swab off again. The will remove years of old junk.
After cleaning the metal and insulating surfaces, use tuner cleaner or protective silicone treatment to seal the surface from air and moisture.

The goal is to **LEAVE ONLY A LIGHT FILM!**

Use cotton balls to wipe off most of the applied cleaner.
**RESOURCES:**

Note: These are great companies that I am familiar with. Most have full catalogs online.

<table>
<thead>
<tr>
<th>Name</th>
<th>Phone</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Sensor</td>
<td>(800) 633-5477</td>
<td><a href="mailto:info@newsensor.com">info@newsensor.com</a></td>
</tr>
<tr>
<td></td>
<td>Fax: (718) 937-9111</td>
<td><a href="http://www.newsensor.com">www.newsensor.com</a></td>
</tr>
<tr>
<td>Mouser Electronics</td>
<td>800) 346-6873</td>
<td><a href="http://www.mouser.com/ti">www.mouser.com/ti</a></td>
</tr>
<tr>
<td>Allied Electronics</td>
<td>(800) 433-5700</td>
<td><a href="http://www.alliedelec.com">www.alliedelec.com</a></td>
</tr>
<tr>
<td>Antique Electronic Supply</td>
<td>(480) 820-5411</td>
<td><a href="http://www.tubesandmore.com">www.tubesandmore.com</a></td>
</tr>
<tr>
<td>Mojo Music Supply</td>
<td>(800) 927-6656</td>
<td><a href="http://www.mojotone.com">www.mojotone.com</a></td>
</tr>
<tr>
<td>Groove Tube</td>
<td>(818) 361-4500</td>
<td><a href="http://www.groovetubes.com">www.groovetubes.com</a></td>
</tr>
<tr>
<td>Parts Express</td>
<td>(800) 338-0531</td>
<td><a href="http://www.parts-express.com">www.parts-express.com</a></td>
</tr>
<tr>
<td>Ultratone Amplifiers</td>
<td></td>
<td><a href="http://www.ultratoneamps.com">www.ultratoneamps.com</a></td>
</tr>
<tr>
<td>Weber Speakers</td>
<td>(765) 452-1249</td>
<td><a href="http://www.webervst.com">www.webervst.com</a></td>
</tr>
<tr>
<td>Ampwares</td>
<td>(610) 357-3631</td>
<td><a href="http://www.ampwares.com">www.ampwares.com</a></td>
</tr>
</tbody>
</table>