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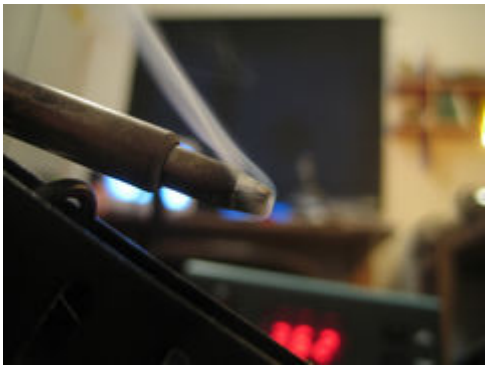
The art of soldering

The quality of all soldered connections affects the sound of your system, both in the power supply and where the audio signal travels. The differences are not subtle, but rather significant. Some people first discover this when they replace worn out plugs on their speaker cables. After the change, it sounds different. Often the sound gets better, but occasionally it gets worse. In spite of having shiny new plugs fitted! Others have noted how interconnects of the exact same type can sound surprisingly different. It is the musical signature of the soldered connections they are listening to. Usually it varies a lot more than high quality cables or connectors do.

In the early 90's, I started a methodical investigation of how to make good soldered interconnects and speaker wires. I worked as an audio system installer, technician and salesman and soldered on a daily basis. The best cable I had made so far was put away as a reference and I tried different methods to improve upon it. In this way I tried to find out what parameters were important to the sound of the soldered connection, and in what order they were important. It was very difficult because the results were not completely logical.



The breakthrough came about ten years later, when I bough a better soldering station; a Weller WSD80 with digitally adjustable temperature and 80 Watts of heating power. Now my results became much more repeatable and I could make cables that sounded exactly alike if I did them in the exact same way. My interest and curiosity was renewed and I set up a structured way of comparing the possible parameters. I worked several evenings each week for more than a year and tried all the

different solder wires I could get my hands on. I even ordered solder from the Japanese industry that was unavailable in Europe, because somebody told me they had a very special sound to them. Eventually I summarised what I had learned.

The following parameters affect the sound of the soldered connection, of which the first five are the most important:

- The flux
- The temperature
- The technique
- The equipment
- The age of the soldered connection
- The solder metals (tin/lead/other metals)
- The time
- The purity of the soldered surfaces
- The amount of solder used

The flux makes a dramatic difference to the sound quality. Both the aggressiveness and the amount of flux used affect the sound quality. Too little or too mild flux is both hard to solder with and sounds harsh and edgy. A flux that is too aggressive often makes the sound heavy and boomy.

The temperature is very interesting. After having found that different fluxes have different optimal soldering temperatures with audible differences down to one degree Celsius (yes!), I walked right into a trap. I chose the best soldering wire, determined its optimal temperature and thought that was it. I soldered a lot of cables that all sounded great. Around half a year later a good friend called me up and said he'd made a discovery: The cable that was made half a year ago sounded clearly worse than the one that was brand new. I said OK, I know about that effect. It's sad that they age so fast but there is nothing I can do about it.

Then the interesting part came: My friend said that an old experimental cable, soldered with a higher temperature, now sounded the best of all!

I had to start from the beginning. I soon realised that the difference a higher temperature makes to the sound is counteracted by the aging. So, to make a cable that sounds best when new, one uses an optimal temperature, let’s call it T. As time passes, the soldered connections of this cable will sound increasingly dull and stiff. But if you start with a higher temperature, let’s say T+10 degrees, the sound character will at

first be a bit too lively and uncontrolled. But after a few months, this cable will sound fantastic. The aging process “stiffens” the sound and these variations in sound quality are audible for almost 4 months. After this period of burning in, the soldered connection will sound exactly the same for many years. I have noted no audible change in cables well over a decade old.

The technique is important to get reasonably right, but you don’t have to be a professional. In short, it’s about cleaning your soldering tip, adding a drop of solder to it and get a good physical contact with the largest mass of the metals you are about to solder. Then you wait for a while to let the heat transfer into the metal and then add the solder to the joint (not to the soldering tip!) fast and smooth. Last of all, you remove the solder wire and let the tip rest a bit on the joint, then remove the tip. The last moment (a few seconds when doing big jobs) is to let the temperature rise to the optimal. As the solder cools and goes solid, it should lie absolutely still and cool by itself. Do not blow on the joint.

The equipment must incorporate an adjustable temperature, the tip has to be of the right type for the job and the power must be sufficient.
The most affordable soldering stations/pens that give a good result are those that have a fixed temperature, set by the tip. If using such equipment, you should choose the tip temperature that is closest above the optimal temperature for the solder. The bigger the difference is between tip temperature and optimal temperature, the faster the soldering job has to be completed. By being fast, you get a colder final temperature of the joint and with practice the results can be reasonably good and consistent. Some pre-heating of the metals is still required, it is the application of the solder and final heating that you do faster. The power of the station/pen should be at least 50 Watts for most jobs.

Some high tech soldering stations use hot gas, such as nitrogen, to pre-heat the metals. The advantage of this is that the surfaces don’t oxidise during heating. These machines usually cost a fortune, but I assembled some reasonably priced parts and made soldering experiments in a heated nitrogen atmosphere. Unfortunately the results were no better than when soldered in free air.

The age of the soldered connection has a strong effect on sound quality! With an optimal soldering temperature, the sound will constantly change for almost 4 months. A very strange feature of the burning in process is that the sound quality goes up and down during this period. When new, the joint sounds very lively, open, impressive and almost a

bit uncontrolled. Then it periodically dives into a state where it sounds compressed, metallic and grey. During these "grey periods" the sound quality can be worse than a screwed joint. Remember that it's the final result that matters and please do not make comparisons between different soldering jobs unless they are fully "burned in" - which means that they are at least 4 months old and have had some use during this time. Please **beware** of machines that claim to “burn in” cables – I have tried several of these and they have all made permanent damage to the treated cables! The effect seems to slowly wear off, but not completely.

The solder metals come in various compositions. There is completely lead-free solder, the traditional tin/lead alloy and solder with silver or other metals for extra physical strength etc. My conclusion after having tried many lead free solders is that the metals are of far less importance than the flux. If the right flux is added, most metal compositions can sound rather good. Best of all is still the traditional tin/lead alloy (60% tin and 40% lead), but these days (since the RoHS directive was implemented in the EU) this is only allowed for repair work. For manufacturers the lead free versions are mandatory, but this is no big problem because the best of the lead free solders are very close in performance.

The time is actually less critical than one may suspect. If you heat for too long, so that the insulation of wires and connectors melt considerably, the sound seems to get worse. But if you are reasonably effective in your work, the results are good and consistent. It is, however, vital that the temperatures rise to the optimal on the metals that are soldered. Therefore it’s better to err on the too long side than make a soldering job that is too cold. Please note that this does not apply when heat sensitive parts are soldered, such as loudspeaker units. In such cases, the best technique is to increase the temperature slightly and work fast with a large contact area between tip and joint.

The purity is not as critical if the solder has a good flux. Wires and metal parts should not be heavily oxidised, but additional cleaning of visually clean surfaces does not bring much of a sonical improvement.

The amount of solder used should not be too small. On professional courses in soldering, one is taught to use a minimal amount that just covers the soldered surface and a very narrow border around it. For the best sound, however, one should use a bit more. In hollow part such as the central pin on RCA connectors, the hole is best filled with solder. On speaker cables the solder should cover all strands of the cables.