
SOLDER REWORK RECOMMENDATIONS FOR HV CERAMIC CAPACITORS

INTRODUCTION

Recommendations offered in the Application Note are intended to provide general guidelines for reworking multilayer ceramic capacitors and capacitor assemblies. They reflect industry accepted protocols and should, if applied properly, provide a basis for a reliable result. These recommendations may not be applicable to all situations however and as such should not be considered as a guarantee for success. Consequently, it becomes the engineer's responsibility to monitor and confirm all results and make adjustments where necessary to accommodate specific conditions.

GENERAL CONSIDERATIONS

The aspect of having to perform rework has become such a common place occurrence in today's manufacturing facilities that we tend to overlook the obvious fact that it can have a negative impact on our ability to successfully conduct business. Several factors including the questionable integrity of the repaired device or assembly, an overall reduction in productivity, increases in material and labor costs and delays to delivery can alienate customers and detract from the bottom line. Consequently, when contemplating the option of repairing or not repairing solder joints the engineer needs to consider whether rework is really necessary and above all determine what can be done to prevent further episodes.

It has been expressed in several application notes that ceramic capacitors are highly susceptible to thermal shock and that the type of process being selected for installation is critical to minimizing the possibility that the capacitor may be exposed to high levels of thermal stress. During this initial soldering phase, the engineer has several options to choose from and has the advantage of being able to select a process that best matches his specific requirements. Unfortunately, when rework is required, the processing choices become extremely limited and this situation can place not only the capacitor at considerable risk, but the entire assembly. Consequently, rework should always be the last option and the engineer should first determine whether the defect poses a reliability concern or whether the issue is in fact purely cosmetic. If the condition poses no risk, the engineer should forego rework, accept the product as is and instead focus efforts on determining the root cause for the anomaly and modify the process to minimize the likelihood of a reoccurrence.

Given the number of variables that can influence the outcome of a soldering process, the engineer should not expect to always achieve optimal results during the prototype stage or preproduction and may in fact be required to make minor adjustments during the production phase to further refine the results. The best approach to limiting the amount of rework that needs to be done is to continually monitor the outcome and adjust the process accordingly.

If a situation arises where rework becomes unavoidable, the engineer will first need to classify the type of repair required and determine the most reliable course of action. For this purpose, repairs can typically be classified as requiring either "touch-up", "realignment" or "removal and replacement".

A hand soldering process similar to those outlined in application notes AN101 and AN103 will apply for the majority of reinstallation steps, but potential issues related to thermal shock are much more difficult to address, particularly for surface mount chip capacitors. Although problematic, preheating of the capacitor is still a critical component of a successful rework process and if the use of a pre-heat oven is not feasible, the engineer may want to consider the use of a hot air torch, especially for larger capacitors and densely populated boards. This will help to localize heat around the component and slowly bring the temperature up to a point where the use of a soldering iron will present much less risk and be much more effective. Remember that the soldering iron tip should under no circumstances be allowed to make direct contact with the replacement capacitor and that the time to complete the reflow operation should always be kept to a minimum.



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TOUCHUP

The term "Touchup" implies that there is either insufficient or excess solder present. For an insufficient solder condition, if the capacitor appears to be properly aligned, the addition of a small amount of solder should correct the issue. Solder should be added to the tip of the soldering iron and then allowed to flow into the inadequate solder joint area.

If excess solder exists and the capacitor appears to be salvageable, an approach similar to adding solder should be utilized. A small amount of flux and / or solder may be required to facilitate reflow after which the solder can then be removed with the aid of a vacuum extractor or braided copper solder wick.

REALIGNMENT

Realignment of a capacitor is not recommended once it has initially been placed on the board and is not feasible after the component has been exposed to the reflow process. A successful soldering process is highly dependent on ensuring precise volumes and placement of the solder paste and accurate positioning of the capacitor. Altering this prerequisite condition by sliding or rotating the part will significantly increase the risk of incomplete solder joints, solder balls, solder bridging and tomb stoning.

If realignment becomes necessary, the best opportunity would be prior to the adhesive curing and / or the solder reflow process. The best results are achieved by using a vacuum pencil to carefully lift the capacitor straight up off of the board, correct the alignment and then reinsert the component back down into the solder paste.

If an adhesive has been utilized as a means for securing the capacitor and this epoxy has been cured and / or the initial soldering process has been completed, attempting realignment is not recommended as damage to the capacitor is highly probable. Efforts should instead be limited to removal and replacement of the capacitor.

REMOVAL AND REPLACEMENT

For the removal of a previously soldered surface mount chip capacitor a small tip soldering iron or heated tweezers can generally be used to help complete the process. A small amount of flux may be required to facilitate reflow and depending on the mass of the capacitor a hot air torch may be required to help bring the entire assembly up in temperature. If this option is utilized, attention needs to be taken to ensure that air flow is limited to the capacitor being removed and that exposure to surrounding components is restricted. A braided copper wick or solder vacuum should be used to remove the majority of solder prior to capacitor removal and can help to prep the surface for installation of a new capacitor. When lifting the capacitor off of the board special care should be taken to ensure that no other components are touched and that any remaining solder is not displaced from its current location. If the capacitor has been secured by adhesive, the part can be released by applying a rotational twist.

If rework requires the removal of a leaded capacitor, the most reliable approach would be to first separate the leads from the capacitor body thereby reducing the larger overall mass of the device. With the body removed the leads can easily be unsoldered and extracted with little risk to the rest of the assembly by using an approach similar to the process outlined for a surface mount chip capacitor. Even if the body cannot be separated from the leads this process should be adequate but the use of a hot air torch may become more of a necessity

Reflow times should be kept to a minimum to limit the possibility that the board and surrounding components may become damaged. Although the actual process parameters for component removal can vary, contact between the circuit pad and soldering iron or tweezers should be limited as much as possible to something less than 6 seconds.



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CAPACITOR RE-ASSEMBLY

Prior to reassembling a replacement capacitor, the PWB should be cleaned thoroughly, excess solder and any residual adhesive should be removed, and the board should be inspected to ensure that the solder pad has not lifted and that no other damage has taken place during the removal process.

If the board assembly is deemed acceptable, the solder pad areas should be reconditioned by either pre-tinning the surface or adding a new layer of solder paste. Non metallic tweezers or a vacuum pick up tool should be utilized to reposition a replacement capacitor and soldering can be performed by using the applicable hand soldering process outlined in AN101 for surface mount components or AN103 for leaded capacitors. If the option of using a heat sink or an air circulation oven for preheating the capacitors is not practical, a fine tip, hot air torch may provide an acceptable means of achieving the desired results. As discussed in previous sections of this application note, improper control of an air torch can result in damage to the board and adjacent components and as such, care needs to be taken to ensure that air flow is limited to only the area that is being soldered.

After rework has been completed, the entire assembly needs to be re-inspected to ensure that any newly installed capacitors, surrounding components and the PWB itself has not been damaged.

Summary / Key Considerations

- ⚡ **Rework should only be considered as a last resort.**
- ⚡ **Always consider removal and replacement before realignment**
- ⚡ **Restrict all heating to the rework area to avoid collateral damage**
- ⚡ **Ensure that the soldering iron does not make direct contact with the replacement capacitor**
 - ⚡ **Limit reflow times to as short as possible**
 - ⚡ **Re-inspect entire board assembly upon completion**
- ⚡ **Always determine root cause and implement corrective action**



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