A practical approach to Electronics

PART 4

Salvaging damaged PC Boards

Most printed circuit boards will survive reasonable abuse during their useful life, repairs being mainly confined to the components mounted on them. However, they may be damaged in various ways and must be either salvaged or replaced.

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Ordering a new board may involve lengthy delivery delays, during which time, the owner is deprived of the use of the equipment. In such circumstances, the costs may be considered excessive.

Boards can often be salvaged at a reasonable cost unless they are severely damaged. In this article, two approaches are considered: (1.) re-assembly of the broken board and (2.), duplication of the board by the repairer.

Removing the board

Before removing the board for service, examine both sides for cable connections. Draw an outline of the board first, then draw lines representing each cable. List the colour of the cable, and its use in the circuit; also, its point of connection at the other end (transformer, switch etc).

You will need these listings in case you forget the exact location when reassembling the board. Drawing the outline of the components near to the cable connections will help locate the correct position from your diagram.

You may find several cables with the same colouring. In this case, label the wiring with masking tape before removing it from the board. Make sure the wording is listed against the corresponding line on your diagram.

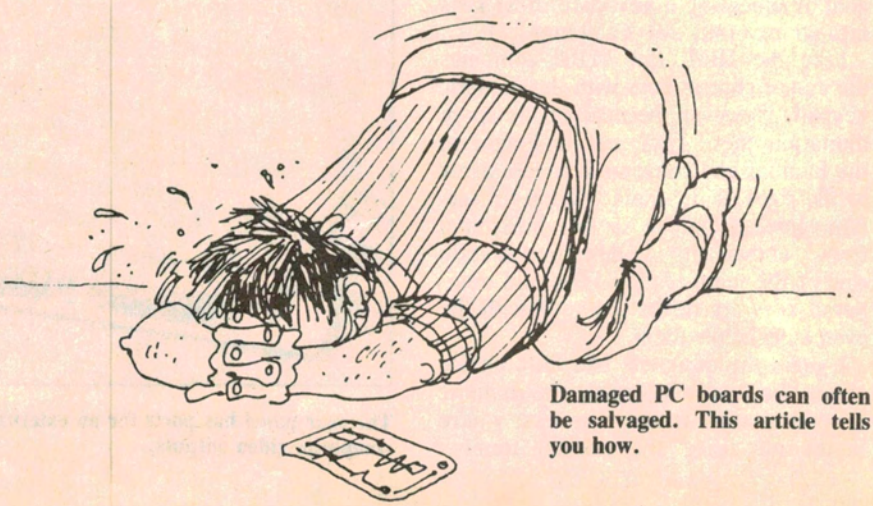
Where a circuit board has a large number of connecting cables, and several hundred pads (such as a car radio-cassette), it will be practical to draw a layout such as the one described above. In this case, even the removal of one wire may make the original connection point difficult to locate.

About the only solution to this is to cut the cable using side cutters. Cut close to the board, leaving 3 or 4 mm of insulation still attached to the joint. This will enable positive identification amongst a mass of 'look-alike' pads. Where a colour has been used twice, cut one cable off at right angles, and the other at 45 degrees, so there is no confusion. Make sure that you match the ends before stripping and resoldering, otherwise the identity of the cable may be lost.

Work only on one wire at a time. On some units there may not be enough slack cable to enable rejoining, if the suggested 3-4mm is left on the board. You will then be forced to cut much closer to the surface, leaving only a small 'ring' of insulation remaining. Care must be exercised so as not to accidentally remove this small ring, by dragging the board across the bench, or brushing it off.

One precaution to note with the system is to make sure that all the strands of short wire are removed from the copper pad before attaching the original cable. Should a pad lift from the surface, it may be fixed to the board by a drop of contact adhesive applied on the end of a toothpick. Further security may be obtained by a small dab on the component leads on the other side as well.

Some boards are more conveniently removed with the cables attached, disconnecting the ends from transformers or sockets, etc. A diagram of the connections to the boards is still advisable (apart from the diagram of cut connections), because in handling the board during the course of repair, one or several wires may break off.



Damaged PC boards can often be salvaged. This article tells you how.

A fairly practical method to reduce the likelihood of accidental fracture is to tape the cables to the board with masking tape. A break may still occur, but in this case the offending piece will be held in position and the broken end then points to its proper place.

Also, with the loose cables taped down, handling of the board becomes easier. Removal of the tape when repairs are effected should be done slowly.

The most convenient method of anchoring cables to the board is to feed the cables to the edge and tape them down firmly. Leave about one centimetre or so of tape over the edge, then apply a similar length of tape to the other side, again allowing about a one centimetre overhang. The two adhesive surfaces should now be brought together, so as to form a 'sandwich', with the cable and board in the middle.

This relieves any strain on the joints caused by the cables swinging with mobile use or in places where there is constant vibration.

Whilst the adhesive will eventually dry out and become hard, this may take several years, and it is more likely that the board will require servicing well before this occurs.

PVC based electrical tape is not suitable for this purpose, as there is insufficient adhesive coating. The best tape to use for this work is medical tape, which has a heavy woven cloth base and a very tacky white coating.

Hairline cracks

Hairline cracks can occur through shock loading on a board (eg. when the device is dropped) or when insufficient support causes deformation by heavy components. Cracks can also be made by excessive external pressure on board-mounted switches or pots, etc. The latter are, in general, restricted to the locality of the said pressure point and are fairly easy to locate and rectify.

The other type (pre-assembly fracture) may take place if the board is bent during manufacture or transport. The latter are sometimes not visible and, in instances where a batch of several thousand boards is involved, quite a few may pass through unnoticed.

The hairline crack often does not become apparent until the board is fully assembled and tested. The most obvious way to find the fault is to apply pressure to the board by use of an insulated tool, such as a plastic rod. The fault may come and go as the board is flexed, or the circuit may cease to function entirely. Noting which area is the most sensitive to this treatment usually pinpoints the particular tracks. It is then merely a matter of bridging the fracture with wire links and plenty of solder.

Transport damage to a unit is the most noticeable form of physical abuse. The cabinet or metal housing may have dents on one face, or a corner may be pushed in. Sudden shocks from this sort of treatment may cause heavy components to pull right off the board, or cracks may occur when the housing distorts, straining the board with the change of shape.

In salvaging those boards it is important to firstly restore the original shape of the housing, such that the mounting holes in the board match those of the cabinet. Fitting a repaired board without doing this will apply undue pressure to the board and consequently a re-occurence of the fault condition. In some cases, enlargement of the holes may be the only solution.

A more subtle condition arises when a unit is dropped dead flat. No external damage is apparent, but the innards may have taken a severe jolt. Removal of the cover may reveal a loose transformer, and various screws may have pulled away.

A safe bet in the above cases is to examine the board close to the mounting posts. Often, these are rigid and inflexible; any sort of fracture near them should arouse suspicion.

Large capacitors, such as filter types, can exert enough stress on impact to cause hairline cracks. Grasp the capacitor body firmly then rock the component slightly. This may reveal a crack that is otherwise hidden underneath. Otherwise, the board may have to be removed and carefully examined.

Locating hairline cracks

Several methods are applicable in aiding crack detection in PCBs.

A slight flexing of the board when removed can show up the larger cracks, while lesser cracks may be seen when the board is held up to the light. It is preferable to use daylight as a source, holding the board in a vertical position, and then tilting it to and fro slightly to show the slight difference in colour between the main (unaffected) base colour and the lighter shade exhibited by the crack.

The most difficult of all to find are the very fine fractures. Some of these are so slight that they are not visible, even with a good light and strong magnifier. Some of these may be confined to only one or two tracks, being very

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localised. Flexing the board in this case will achieve nothing positive, as some of these do not penetrate the board, being confined to the surface only.

A more extreme and frustrating condition arises where only the copper track is fractured. The board has flexed in such a way that the copper has reached the elastic limit and parted at the weakest point. This does not imply that the narrow part of the track is the place to look. The particular track under these conditions may appear intact.

In some cases, the gap at the point of fracture will have closed physically, but not electrically. Even worse, the application of multimeter probes to a track in this condition to test continuity will read dead short. The current passing across the small point of contact is enough to operate the meter, but will not carry the load current to allow the circuit to function properly, if at all.

With plain copper tracks, the solution is to power up the circuit, provided it operates on low voltages or proper safety precautions have been observed, and the said board is rigidly fixed in place. Now take a hard "lead" pencil, such as a 2H or 3H type, and carefully run the tip over the suspect track. Make sure that you do not run off the track onto the board, as the graphite is conductive and will short out adjacent tracks.

On crossing the fracture the pencil effectively bridges the fine gap and its exact position is then apparent.

Note that the pencil should be covered with clear PVC tubing, such that the top end is covered by an extension of at least 25mm. The graphite core of the pencil is live when in contact with the circuit, and should be well insulated to prevent shock.

Boards covered with a solder-resistant lacquer present problems not found with uncoated boards. Firstly, the green coating obscures all but the most serious cracks, when attempting to use the backlighting technique. The suspect area may require removal of the lacquer to expose the copper.

Before this is done, however, examine the board with a good magnifier. Sometimes the copper will show at the edge of the fracture, the red colour contrasting well with the green coating. Removing the lacquer by scraping with a sharp knife may well hide the gap entirely.

Hairline cracks can develop for all sorts of reasons.

One type of fracture shows up as a spidery pattern (multiple fracture running from one point). These are commonly found where heavy components are mounted on the board or at corners where the board is fixed by means of screws to posts or insulated mounts. These should be reinforced, as described later in this article.

Regardless of the type of crack, small or large, steps should be taken to determine the direction of the crack. The tracks along the path of the crack should also be bridged with wire reinforcing, in the event that the crack runs further.

Board reinforcing methods

All damaged boards should be strengthened to minimise further breakdown.

The most important aspect of board repair is the correct adhesive and surface treatment. Super Glue (cyanoacrylate), has good penetrating ability, but is too brittle when set for butt joins. Araldite will cover the crack and adhesion to the board is good, as long as the components are well mixed before applying.

An easy, low cost, and less messy method is to apply a coat of Bear Contact Adhesive to both surfaces of a broken board, and then push these together.

Sufficient adhesive should be used so that a bead of adhesive forms at the line of contact. Support of the whole board overnight is suggested until curing is complete. Clothes pegs may be employed to hold the edges level; these act as spring-loaded clamps. To prevent a peg sticking to the board, apply a piece of sticky tape to each jaw. The pegs can then be removed after setting has taken place, and the tape then peeled from the board.

Where space permits, scrap pieces of circuit board cut to suit, may be glued on the board across the crack. This supplies rigidity to the repaired board and prevents sagging at the joint.

Partly cracked boards may be strengthened in the same way. Boards with corners broken off require a patch to be glued to the affected area. Glue the piece on the top of the main board (make sure that the copper foil is removed from the scrap piece), even if the piece required covers some component holes. These holes can be drilled out the following day and the parts remounted on the new piece.

Styrofoam blocks may be used to support the board after repair. Blocks may be cut from ceiling tiles, which are of a convenient thickness and readily available from hardware and home decorator outlets. Blocks may be joined using Aquadhere Adhesive. This glue will join a styrofoam block to timber or metal.

With metal, allow 24 hours for complete setting, due to its non-porous nature. Provided there is no oil on the metal surface, the bond is very strong, in fact, the block will break into pieces, before it will lift from the metal. Painted surfaces will also hold well if cleaned first with methylated spirits.

Leads protruding through the underside of the board need not be trimmed when using foam blocks for board supports. These will penetrate the foam easily, and aid in holding the board in place.

Burnt boards

Burnt boards are not a rarity. Many TV sets use SRBP for all their boards. These can fall victim to the heat from high-wattage wire wound resistors. Several types of burn occur:

(1). Dark brown area with board intact.

(2). Charred patch with raised blister.

(3). Hole burnt right through the board.

In category (1) the area affected has a level but discoloured surface, and the most serious problem could be the state of the tracks.

A typical history of such a board would be heat from the leads causing deterioration of the adhesive bond between the copper track and the board. Along with this, the solder loses its tin content, and appears dull grey and wrinkled. The weight of the resistor then causes the leads to sink through the board, and detachment of the copper track begins.

These boards can be salvaged by fitting a piece of uncoppered board over the area and fixing this with 6BA screws. This done, attach wire links to the resistor in place of the burnt tracks. Double-sided copper circuit boards may be cut to a suitable size, drilled, and slid onto the resistor legs. This arrangement acts as a heatsink, and reduces the amount of heat reaching the main board. Solder should be applied to both sides of the foil.

On badly burnt boards, it may be easier to cut two pieces of uncoppered board to cover the area where the resistor leads fit the board. Fit one piece on each side and drill through the original holes, then fix both with 6BA screws.

The resistor leads may now be soldered directly to the screws after wrapping several turns around them.

In groups 2 and 3, the boards would be in very poor condition. If they are small, it may be practical to reproduce the board. A quick method is to firstly draw a diagram of the layout, and mark the identity of each component. Then remove all the components from the board. Cut a fresh piece of board to the same dimensions, lay this copper side up, then place the old board track side up and use it as a drilling template.

Drill one hole and insert a thick wire or a board pin, then drill the next hole and insert another pin or wire. This will prevent the boards from moving when the other holes are drilled. After all the holes are drilled, lay the boards side by side, and then copy out the tracks with a Dalo etch resist pen, using the original board as a guide. Check the track pattern before etching.

Some burnt areas may be small, and not warrant a reproduction. If some of the tracks are destroyed, the area may be removed by a drill or file. A small 'sub-board' can be built from Veroboard, and the parts concerned mounted on this. Solder stiff wire through the holes in the Veroboard, then drill holes in the main board to enable reconnection. The finished 'sub-board' should then look something like an overlarge IC, sitting clear of the surface.

With vertically mounted resistors, a piece of board may be inserted between the body and lead, and the lead soldered to the copper. Tinning the board with solder, and cleaning and tinning the resistor lead will enable a quick secure joint to be made.

Copper tracks

Copper tracks may be found to have burnt and lifted from the board. It is not advisable to glue these back into place and then attempt to solder in replacement components. The condition of the tracks renders them virtually unsolderable, they are physically weak, and their current carrying capacity is reduced. Replacement of the tracks is possible using a self-adhesive copper foil.

Remove the old foil back to a clean shiny area, then attach the new copper strip directly from the roll. Should the foil not adhere, roughen up the surface with emery cloth.

Wire links may be used to replace burnt tracks. Note that the wire will need to be fixed to the board with glue. Care must be taken when soldering component leads to wire; these joints often prove to be unreliable unless a small loop is made on the end of each wire to substitute for the copper pads.