PCB Reverse Engineering

by John Armistead

This article concerns itself with the hardware reverse engineering of printed circuit boards only. Software or firmware reverse engineering is not addressed here.

The process:

The need for printed circuit board (PCB) reverse engineering or re-engineering comes about for a variety of reasons chief among them is the need to replace an obsolete PCB that is no longer available from the original manufacturer. Missing manufacturing files such a Gerber files are often sited as the main reason. Another reason is cost. Some PCB's are considered proprietary by the OEM when in fact they are not; they are just too expensively priced.

Re-engineering a PCB assembly can provide an improved or added performance to an old process. New and improved materials and techniques may be utilized improving operations, maintenance and support. Reverse engineer your PCB first as a base set of data and then modify that base to obtain a more modern PCB that is both less expensive to build and less expensive to service.

There are at least four basic steps in reverse engineering a printed circuit board.

1. Obtain at least two samples of the board. Measure all chip capacitors in place then remove all components and log them. Identify all components and obtain specifications for each. This process will usually render one sample board unusable again. One board should be retained intact and utilized as a reference board. That board should remain usable again. The identification of all components is required for the bill of materials (BOM). The BOM is utilitzed for component footprint information necessary for the production of Gerber files.

2. Identify all of the electrical connections between components on the board (node list,

Modification of these basic steps is often necessary most notably for high frequency boards. Due to high frequencies on traces, trace length, position and impedance can be very important. Utilizing x-ray technology in combination with deconstructing the board to reveal trace position (length, width, thickness, layer position) will help the engineer understand where high frequency traces need to be routed.

The previous steps will cover about 95% of all printed circuit board reverse engineering requirements.

The Patent/Copyright issue:

If a board has a copyright mark, then you should not reverse engineer the traces verbatim. Rerouting the board using any one of the auto router software packages will generally render a board that is unlike the existing board although still electrically and schematically identical.

The majority of the patented boards are patented for onboard firmware or highly specialized digital circuits. Unless you have very deep pockets, this is one PCB reverse engineering area that it is advisable to stay away from altogether. Of course, if your company owns the patent then there is no problem.

What you should expect from a PCB reverse engineering project:

- Complete schematic diagrams including any on board, point to point, wiring diagrams. Schematics should be rendered in a form that most electrical engineers would recognize and understand.

- Complete bill of materials including individual data sheets on each component.

- Complete Gerber files for the production of

sometimes called a net list) and build a schematic. This process requires an experienced electrical engineer to be able to render the emerging node list into a readable schematic. Accuracy here is most important.

3. Capture the schematic in software including building component images for all components that are not in a parts library. Check the schematic connections to the board.

4. Generate Gerber files for the board.

the PCB with a set of printable PDF files.

• A prototype PCB assembled with components for testing and evaluation.

Conclusion:

Reverse engineering PCB's is a necessary process to obtain lost manufacturing files (Gerbers). Sometimes, reverse engineering combined with re-engineering can revitalize old circuits to save time and money.

Reverse engineering, redesign or re-engineering your PCB assemblies can be done quickly and economically. Original drawings can be provided with a pre-production prototype for testing and evaluation.

See also Thoughts on reverse engineering PCBs offshore.

About John Armistead
Click here to see typical files for a Reverse Engineered 4 layer PCB.

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