I J C T A, 9(37) 2016, pp. 113-117

Development of Direct PCB Clad Printer

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Abstract: This work proposes the development of direct a printed circuit board (PCB) clad printing machine for creating fabrication mask layer on copper clad for either single sided/double sided PCB board. A low-cost of fabrication PCB is presented in this work on comparing with existing methods like Laser Engraver Method, Milling, Silk Screen Printing and Toner Transfer Method. The proposed method is simple to use and low cost but consumes less time. Direct PCB clad printer was developed by modifying the mechanism of the conventional paper printing inkjet printing machine to print directly on copper clad. The fabricated printer was tested to print circuit layout on single side PCB and output meets the desired characteristics.

Keywords: Printed circuit board, inkjet printer, direct PCB printer, direct clad printer, PCB mask printer

1. INTRODUCTION

Printed circuit boards (PCB) are copper clad plain boards on which electrical/electronic layout for circuits are created for mounting electronic components. The conductive circuit is mostly copper, although aluminum, nickel, chrome, and other metals are also used. There are three basic varieties of printed circuit boards: single sided, double sided, and multi-layered.

Single Sided PCB has conductors on only one surface of a dielectric base. Typically, the through hole components are mounted on one side of the PCB, with all the leads through holes, soldered and trimmed. Surface Mount Technology (SMT) or Surface Mount Devices (SMD) Components can be mounted directly on the copper track surface. Surface mount circuitry is no smaller than conventional. In practice, most boards are a mix of surface mount and conventional components. It hasdisadvantages such as the two technologies require different methods of insertion and soldering. Conventional circuitry is easier to debug and repair.

Double Sided PCB has conductors on both sides of copper clad. Usually, the two layers are interconnected by plated through holes (PTHs). The components must be mounted on only one side of the PCB, but can also mount components on both sides of the PCB. Surface mount circuitry would be mounted on both sides of a PCB. Multilayer PCB has conductors on 3 or more layers separated by dielectric material, and the layers are interconnected by PTH. Minimum track width requirement is 0.2 mm, and minimum spacing between tracks is 0.2mm. The function of a PCB includes the thickness of the copper laminated to the surfaces. The amount of current carried by the board dictates the thickness of this copper foil. Normally the thickness of the copper foil is standard.

Jerry Branson [1] presented an idea of a laser printer is used to print a circuit layout onto ink-jet paper or specialized transfer paper. The image is then heat transferred to a copper clad board using a standard household clothes iron. The transferred toner acts as an etch resist in a Ferric Chloride ($FeCl_3$) or other etchant baths, such as ammonium persulfate. Alex Triano [2] presented an idea of a desired circuit design is printed onto a transparency film which is then placed on top of the pre-sensitized board. Then, the board is exposed to a uniform ultraviolet (UV) fluorescent light for several minutes. The board then proceeds through the rest of the steps in the fabrication process. Daren Slee [3] presented an idea of lower rate failure modes that can produce outcomes ranging from simple circuit failure to burning propagating faults which may not

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be fail-safe. John Ganjei [4] presented an idea of a driver for using a digital inkjet printer to put down a UV etch resist for PCB inner layer fabrication is pretty straight forward the elimination of all photolithography processes and equipment, i.e. artwork generation, photoresist exposure, and development. Jo S. Kirkenaer [5] presented an idea of the effect of ink limits on primary and secondary colors, and results of applying a method balancing color fidelity to maximize overall perceived color quality. Ali Eshkeiti [6] presented an idea of successful fabrication of a multilayered hybrid printed circuit board (PCB) for applications in the consumer electronics products, medical technologies, and military equipment.

2. PCB PRINTING TECHNOLOGY

The fabricator software replicate pattern on a protective mask on the copper foil PCB layers. Subsequent etching removes the unwanted copper.

A. *Existing Methods of Fabrication:* The following methods that involve in this process:

- Silk Screen Printing: It uses etch-resistant inks to create the protective mask.

Photoengraving: It uses a photomask and developer to selectively remove a UV-sensitive photoresist coating and thus create a photoresist mask.

PCB Milling: It uses a two or three-axis mechanical milling system to mill away the copper foil from the substrate. According to receiving commands from the host software that controls the position of the milling head in the x, y, and z-axis.

Laser Resist Ablation: It Spray black paint onto copper clad laminate, place into CNC laser plotter.

Toner Transfer Method: Toner Transfer Paper (TTP) is the ideal medium for capturing precise laser printer (or photocopier) The circuit image on the transfer paper is then laid face-down over the copper where heat and pressure are applied making the toner image re-fuse again to the copper.

B. *Printing pattern:* In this proposal, non-impact printer in which inkjet drop-on-demand printers is used to realize direct PCB clad printing machine. Inkjet printers are simple devices that consist of the print head mechanism, support electronics, a transfer mechanism, and a paper feed component and it is illustrated in Figure 1.

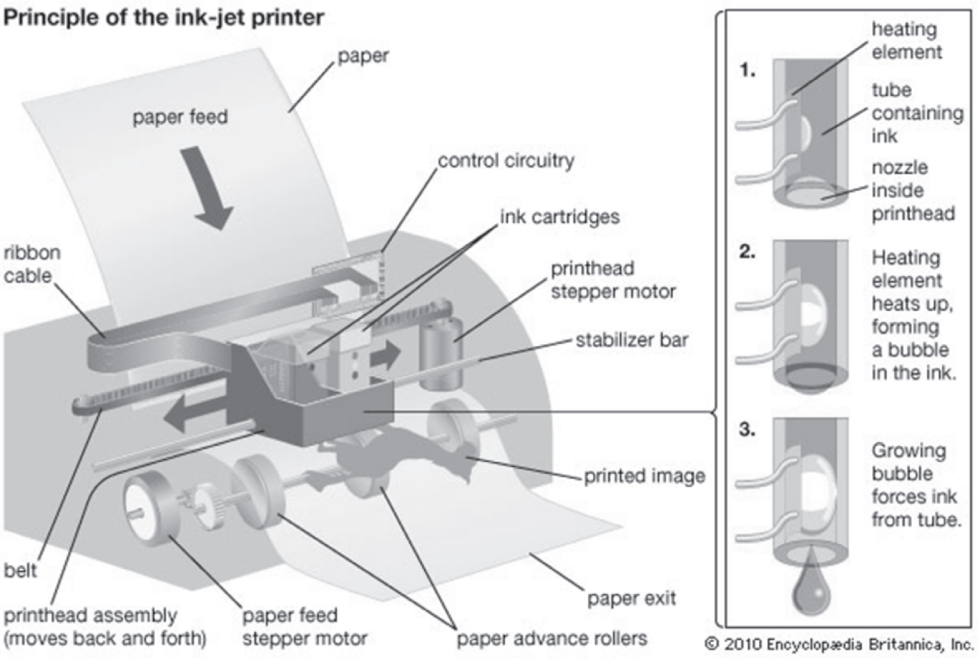

Figure 1: Illustration of the inkjet printer [12]

In this paper modified inkjet printer with piezoelectric inkjet head that creates etching mask of circuit layout on directly on copper clad of single layer PCB and also suitable for double layer PCB that can make the circuit board for desired application with in less time, faster turnaround, lower capital and production costs, simple process.

3. PCB DESIGN AND IMPLEMENTATION

The proposed direct PCB printer is shown in Figure 2. The feeding mechanism was modified for printing on copper clad. The space between the paper rollers and pressure wheel was increased according to copper clad thickness. The paper feed sensors are being relocated because the feeder no longer sends the paper in from the top rear of the printer and lifting and reassembling the print head depend on what to print and the thickness of the material based on usage. However, the print head should not be too close to the copper clad, to prevent damage to the ink cartridges. Printing mechanism is raised to 3/8" to give guaranteed clearance and safety of components. The control circuitry (a small but sophisticated amount of circuitry is built into the printer to control all the mechanical aspects of the operation, as well as decode the information sent to the printer from the computer) should be handled carefully while modifying.

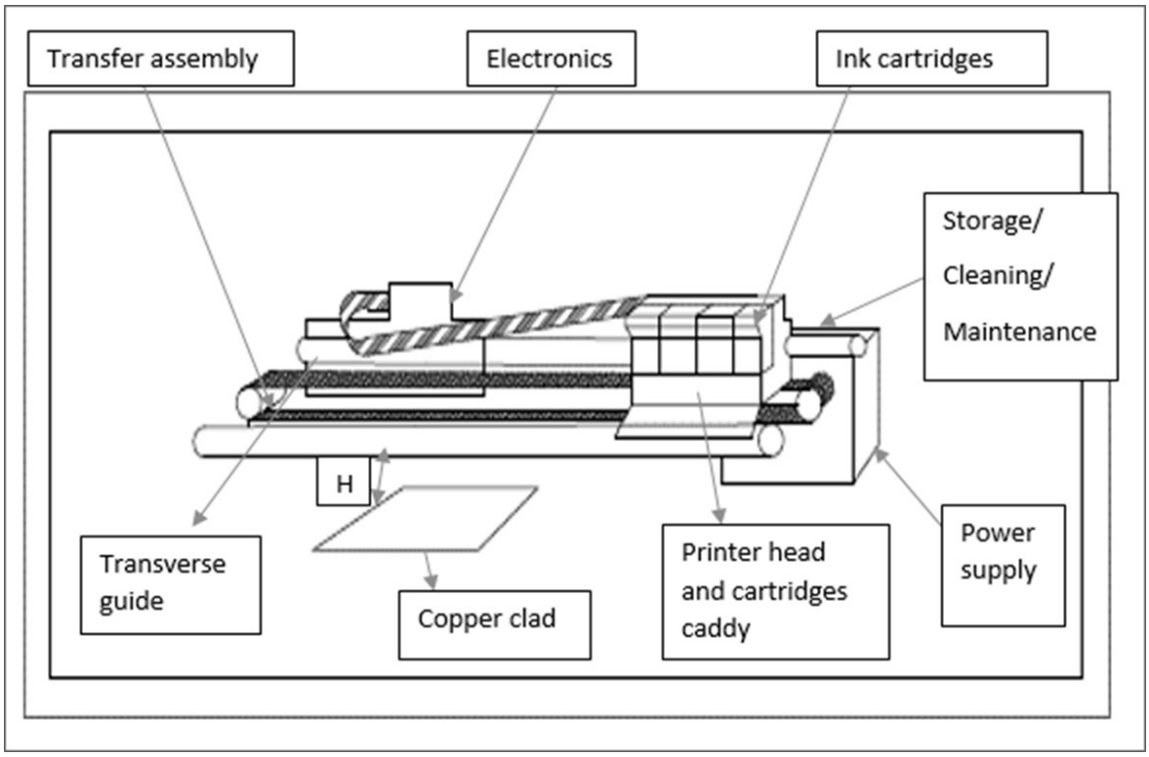

Figure 2: Layout of PCB printer design

4. RESULTS AND DISCUSSION

The direct PCB clad inkjet printer was a prototype and implemented for printing of electronic circuit layout on the copper clad for single side/double side board.

A. *Printing on the copper clad*: Figure 3 shows the modified inkjet printer, printing the layout of the desired circuit directly on the copper clad without any burls, double printer on same lines. The copper clad is slightly preheated to absorb the ink ejected from printer head toward the copper clad. Copper clad is fed to the input of printer at an angle of 180 degrees (horizontal) inserted inside the modified printers, moves toward the clad feeder roller, prints the layout of the circuit on copper clad.

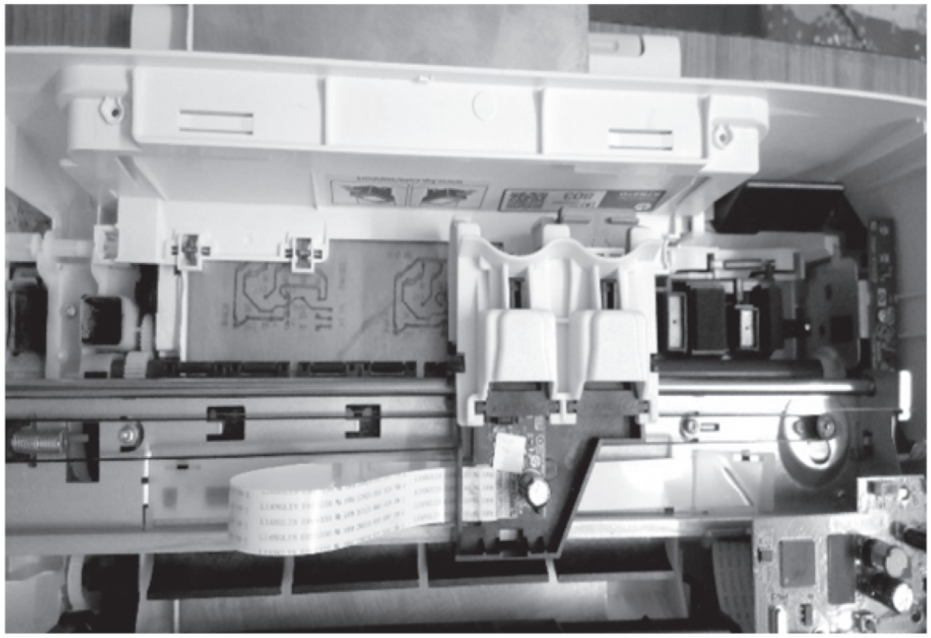

Figure 3: Single side clad printing process

B. *Circuit Layout on the PCB*: Figure 4 shows the desired circuit printed on single sided copper clad board with in less time (<10 s) for this output when compare to the other methods. This process will be a simpler, more consistent, and more reliable system.

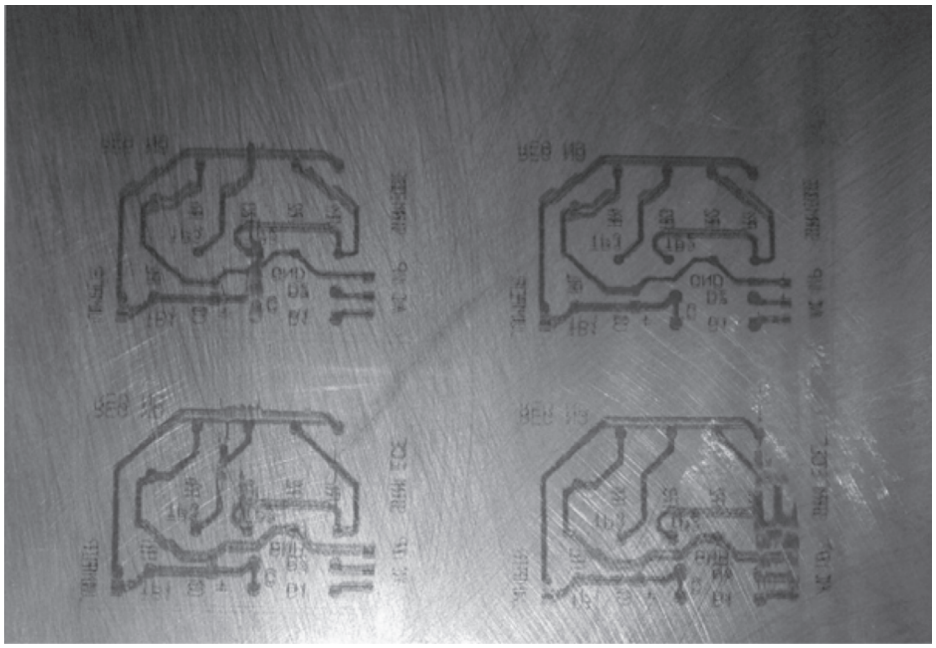

Figure 4: Single side clad after printing process (Mask layer)

5. CONCLUSION

Direct PCB clad printer has been developed using the available inkjet printer. Schematic of the modified printer mechanism is discussed. The circuit layout of single side PCB was printed and yields perfect masking layer. The proposed direct PCB clad printer has more advantages over traditional methods by faster turnaround time, simple process, and lower capital and production costs, easily to handle. This may be well suitable for PCB prototyping and small scale PCB manufacturer.

Acknowledgment

The authors would like to thank the Department of Electronics and Communication Engineering for providing the facility and support.

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