

Laser Marking Process of Printed Circuit Boards

Permanent Traceability of Printed Circuit Boards

The ability to track a circuit board assembly throughout its manufacturing, sales and service cycles is of the utmost importance. Many companies require that each circuit board be marked with a unique bar code identifier that can later be read by equipment that is part of an automated assembly line.

The traceability of circuit boards is usually done by assigning a unique serial number to each board in the form of a bar code. The two most common methods of applying a serialized bar code message to a circuit board are through the application of labels and via laser marking.

Although bar code labels offer a cost-effective solution where small production volumes of boards are involved, higher production cycles benefit from laser marking.

Laser marked bar codes are permanent. The manufacturer no longer needs to worry about labels falling off and not



An example of text and bar codes marked on PC board by removing yellow Hysol ink using a Nd:YAG laser

knowing what the serial number of a board is when it is returned for repair.

Laser marked codes are high quality. No longer does the manufacturer need to worry about misaligned labels.

Laser bar coding allows each board to be uniquely identified, on-line, with very little, if any, operator intervention.

The Marking Process

There are two approaches that can be taken to laser mark a printed circuit board. Unlike alphanumeric character marking that can be done directly on the circuit board's base material, both approaches to bar code marking require that a light colored (typically white or yellow) ink patch be silk-screened onto the board in the

area where the bar code is to be placed.

The **first approach** requires the laser to selectively remove the ink from the circuit board to form the dark bars of the code. The dark bars are the color of the underlying circuit board. The light bars are the color of the ink patch. In the majority of cases a white ink is used to provide the highest contrast between the light and dark bars of the code. To remove the ink from the board a Nd:YAG laser is used. This laser can also be used to mark such items as heat sinks, fans or other components that may be on the board. Many companies find this useful to ensure that original components are returned for repair and to reduce the risk of counterfeiting.

Using the **second approach** the laser does not remove the ink

Rofin-Baasel's StarMark® Laser Marker with Vision inspection system for mark orientation and verification. Ideal for marking pc boards or any product requiring mark integrity.



from the board, but instead changes the color of the ink through a photo-reactive process to produce the dark bars. The light bars again are the color of the ink patch. A waveguide CO₂ or Nd:YAG laser can be used in this application, as is most commonly a yellow colored ink.

The CO₂ laser does not offer as much flexibility as the Nd:YAG with respect to its ability to mark other components on the board, but this approach does offer the advantage that the marking of bar codes can take place on ink patches applied over copper traces on the boards with no risk of damage to the circuitry.

Both approaches are widely used in the electronics industry.

Production Choices to be Considered

There are a few items that must be considered in every printed circuit board marking application, and they are:

Ink Application, Thickness and Consistency

The ink patches are silk-screened onto the circuit board. It is very important to the laser marking process that the ink is applied uniformly from board to board. If the ink is too thin or inconsistent in thickness, a readable bar code cannot be guaranteed from board to board.



A CO₂ laser was used to remove ink from this PC Board to form a bar code. Also shown is an example of 3 different sizes of a two-dimensional matrix code.

It is also important that the ink be uniform in color and that it be able to withstand the many operations that the board will be subjected to after marking, like soldering, cleaning, and day-to-day handling. Rofin-Baasel can aid you in the selection of the ink and the laser for your particular application.

Code Choice

There are a number of factors to be considered in the selection of the bar code font to be used. Common codes used are *Code 39*, *Code 2 of 5*, *Code 128*, and some new 2-dimensional matrix codes.

Perhaps the three most important factors in choosing a code are throughput, real estate and readability. Some codes are denser than others and as such the same number of characters can be marked in a smaller area.

Using *Code 39* as an example, it is typically marked at a density of 9 to 15 characters per inch. The code choice will be

somewhat dependent upon the area available on the board for marking.

A second consideration is throughput. The greater the area (space) contained in the dark bars, the longer the time required to mark. Rofin-Baasel provides free sample marking in our applications laboratory to aid our customers in the selection of a code type and density value during the sales cycle.

A final item to consider is how easily the code can be read in other areas throughout your facility, or by your service centers and customers. Some codes like *Code 39* are more common than others throughout the marketplace.

Board Handling

Once the laser, ink and code are chosen, the next step is to define the way the circuit boards will be loaded into, and unloaded from, the laser marking workstation. Such ques-

tions as, "Will the boards be introduced to the laser 'one-up', or will multiple boards be loaded into the system in a panel?" will need to be answered.

The simplest and least expensive approach is to manually load and unload one board at a time into the workstation. Although this approach is simple, it is very often not practical. In most cases an automated system is required.

A CO₂ laser typically has a smaller mark area than that of a Nd:YAG laser. If the marking system must be able to mark anywhere on a circuit board larger than the laser's mark area, X-Y motion of the laser head or printed circuit board is required.

Most companies request that the laser be integrated directly into their existing assembly lines, and Rofin-Baasel can provide turnkey packages to meet this need.

Cost Savings

Most notably, laser marking saves money! The initial capital investment of the laser and the added cost per board of the silkscreen ink patch are quickly offset by the savings in labels.

A customer manufacturing 100,000 boards per month and applying two labels per board at a cost of 11¢ per label will typically see a complete pay-back on a laser system in as few as 7 to 9 months!