rofin
LASER MARKING

Laser Marking on Circuit Boards

On the grounds of variability, quality, and above all operating costs, laser marking offers a rapidly increasing potential for applications

One aspect of modern circuit-board manufacturing that is becoming increasingly important is the online tracking of individual process steps. This means that the circuit boards must be marked on very small areas. On the grounds of variability, quality, and above all operating costs, laser marking offers a rapidly increasing potential for applications in this area.

With the StarMark series, Rofin has developed a family of laser markers that is optimized to these requirements.

There are many reasons for marking circuit boards in the manufacturing process. One of them is that production status can be queried at any time. This is vital, especially with regard to superior quality standards. A second reason is that error analysis ensures long-term optimization of the production statistics.
Aside from the actual manufacturing process, permanent marking may also be necessary for tracing the production quality of components that have been in the field for some time.

Recently, laser marking in particular has been increasing in importance, compared with ink-jet marking and label marking.
The laser beam offers advantages here, especially those of:

- Permanent marking directly on the work
- No incidentals or additional materials
- Low space requirement
- High process security and availability
- Simple connection to the production line
- Large processable area
- High speed
- Low total costs per mark

Clear text, bar code or DataMatrix codes (see explanation below) can all be written permanently on the circuit board.
Depending on requirements, either Nd:YAG or CO_2 lasers are used.

In the case of the CO_2 Laser (wavelength = 10.6 µm), the spectral absorption characteristics are such that the laser radiation is absorbed by the soldering lacquer. This shows a white discoloration from the applied heat. This marking process is in general more cost-effective than with Nd:YAG lasers; however, the size of the marked area and the resolution are somewhat less in comparison.

Fig. 1. DataMatrix marking with CO_2 lasers. The laser radiation is absorbed by the soldering lacquer. The selective warming causes white discoloration

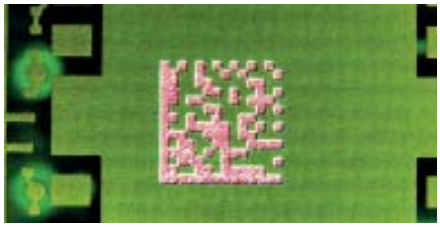

Fig. 2. DataMatrix marking with Nd:YAG lasers. The laser radiation is absorbed by the copper layer. The warming results in the soldering-lacquer layer above this splitting off.

Fig. 3 Diode pumped laser SMD40S (40 W). The short rail (approx. 40 cm) is ideal for integration in production lines.

The time taken for marking depends on various factors, one of these being the size of the code. For example, the marking of a DataMatrix code with 27 characters (3.5 x 3.5 mm² and alphanumeric character set) typically takes less than 2 seconds with CO_2 lasers.

In the case of the Nd:YAG laser (wavelength = 1064 nm), the laser radiation is not absorbed by the soldering-lacquer layer, but only by the deeper copper layer of the circuit board. This causes localized, internal heating. The soldering-lacquer layer above is split off, and the copper layer is exposed locally. In general, Nd:YAG lasers yield somewhat better contrast than CO_2 lasers, and additionally the lenses used allow so-called through-the-lens vision systems to be used for quality monitoring. However, the copper layer oxidizes in the course of months, so that permanent legibility is not guaranteed. Also, the power of the laser must be adjusted to the thickness of the soldering-lacquer layer.

To give an example of the speed, the time taken to mark a DataMatrix code with 10 characters (2 x 2 mm² and alphanumeric character set) is typically less than one second for Nd:YAG lasers.

Fig. 4. Comparison between barcode and DataMatrix. Both the coding examples contain the same information: "WELCOME TO THE WONDERFUL WORLD OF LASER"

Important aspects for the integration of lasers in existing systems are, in particular, compact construction of the laser rail, and a flexible interface connection.

Here the new StarMark Diode, with 40 W and approx. 40 cm rail length (SMD40S) is ideally suited. The diode pumped excitation technology made it possible to develop a special resonator configuration that resulted in an extremely compact laser with constant quality and speed of marking.

The LaserCAD control software is designed for maximum flexibility and customer orientation. For instance, DataMatrix codes can be marked in all formats from 10x10 to 144x144, square and rectangular, with all the usual error correction codes. On request, other 2-dimensional codes, such as PDF 417, Code One, Maxi Code, Snowflake Code or Aztech Code can be implemented also.

In recent years, Rofin has installed more than 80 systems for marking circuit boards. According to customer requirements, CO_2 or diode pumped Nd:YAG lasers were used.

What is DataMatrix

As opposed to the 1-dimensional barcode (e.g. EAN, 2/5 interleaved), the DataMatrix code is a 2-dimensional code. The main advantage of DataMatrix over normal barcodes is the density of information, or in other words the space requirement. Whereas a normal barcode contains 12 – 15 characters, up to 2000 characters can be accommodated in a square with 25 mm sides using DataMatrix.

A further advantage is the low requirement that reader devices have on the necessary contrast. Contrast as low as 20% is sufficient to render the code legible.

By comparison, barcodes require a contrast value of 70 – 80%.

Yet another advantage is that the code remains legible, even when part of it is destroyed.

The DataMatrix code is recognized by the "L" structure at the bottom left. The entire information is contained in the dots within this orientation frame. For example, the DataMatrix code specimen with ECC 200, shown below, contains the information "WELCOME TO THE WONDERFUL WORLD OF LASERS". For comparison, a Barcode 39 in the same resolution and with the same content is also shown.

The DataMatrix code is dynamically variable. It can contain up to 3116 numeric or 2335 alphanumeric characters.

The DataMatrix code is also the only 2-dimensional code that features convolutional and Reed-Solomon error correction. Different ECCs (Error Correction Code) between 0 and 200 are available to permit optimum fulfillment of data security requirements. With the help of the ECC, destroyed parts of the DataMatrix code can be reconstructed to a certain extent. Even when 40% are destroyed, the code can still be read.

The DataMatrix code can be used wherever high security and reading speed are required, and space is limited. It is therefore an established standard in many areas of electronics, automobile manufacturing, the aviation industry and in pharmaceuticals and medical technology

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