The New Frontier of the Printed Circuit Boards

Mobile probe test systems are an unrivalled instrument also and especially in PCB production lines with embedded components. They ensure a perfect compromise between automation, speed, precision and versatility

by **Walter Gueli and Dario Gozzi**

The world of PCBs has changed profoundly since the 1990s. Today, PCBs are increasingly complex, with dozens of layers and smaller and smaller pads.

What's more, in order to produce highly miniaturized objects, constructors have begun to integrate active components, such as microcontrollers, tension regulators or even power components like Mosfet, into the actual layers, as well as passive components.

The choice of material for constructing PCBs with embedded components is very important. It is, indeed, essential to use a support that will not deteriorate over time, or as working temperatures vary. Ceramic is therefore widely used in the construction of this type of PCB, both in consumer electronics and in automotive electronics.

It can therefore be said that, thanks to the remarkable technological progress underway, today the PCB is no longer a passive support on which components are then assembled. It is actually an integral part of the electrical circuit of the finished product. For this reason, new approaches

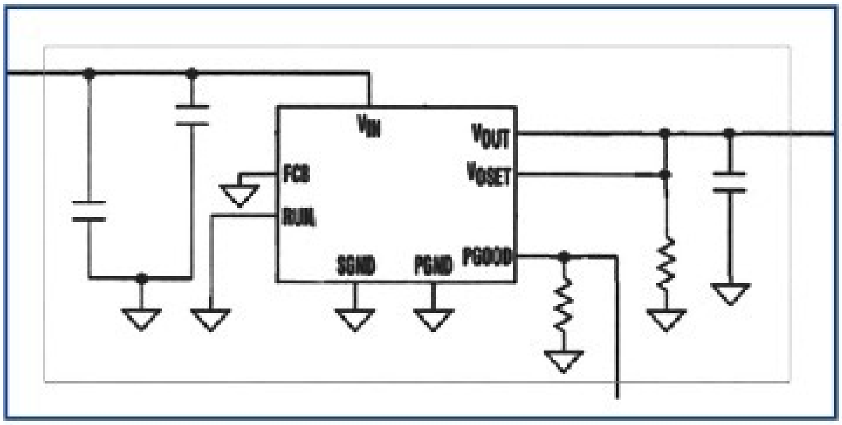

Fig. 1 - Example of an electrical circuit incorporated into a printed circuit

and new methodologies are required to test it, and this opens a whole new frontier for electrical tests, with new challenges to be faced.

Testing Embedded Components

Having thus become an integral part of the electrical circuit, it is necessary to generate an electrical test that guarantees its working order, but at the same time does not damage any of the components incorporated inside.

A PCB test of this kind (**Fig. 1**) requires an approach combining the electrical checks of the tracks with the tests typically used for testing the assembled boards. The electrical test of a circuit with embedded components must include checks for:

- Opens (interrupted tracks);
- Shorts between the different tracks;
- Malformations of the tracks (Kelvin);
- Insulation leaks between tracks (micro shorts);
- Nominal check of the value of the passive components;
- Functionality of active components.

Additional capabilities for ensuring traceability of the PCB, such as reading an electric barcode integrated into the actual PCB, can also be integrated into the test on request.

Being able to do all these checks, while also guaranteeing the integrity of the substratum itself, means raising the level of complexity within the electrical test. Not all the same stimuli can be applied to all the nets. However, the stimuli must be kept in mind and differentiated according to the circuit's configuration. For instance, to check for shorts, a high tension (HV) can no longer be applied "indiscriminately" on all the tracks, because of the presence of components between the layers. What is needed, therefore, is to be able to carry out a "low tension" test on nets with embedded components, and to apply the test in "high tension" for the remaining nets (**Fig. 2**).

Given the capabilities and high flexibility required for an advanced testing system, mobile probe testing systems offer the best and most efficient approach for checking working order of PCBs with embedded components. To carry out a complete and functional test of the PCB, the chosen system must have features suited to the purpose and technologies of the circuits to be tested. These include:

- Precision and accuracy of measurement;
- Immunity to disturbances;
- Variety of stimulating instruments;
- Very high repeatability;
- Mechanical precision;
- Total freedom of movement of the probes in the test area;
- Powerful processing software able to generate a complete test programme without manual intervention.

The continual evolution in the integration of active components inside the substratum has introduced new difficulties, nevertheless, even for mobile probe systems recommended for testing PCBs. For the passive components test (usually with two pins), the architecture of these systems can be adapted. By contrast, it can become a limitation when checking active components, which can have up to four pins to be contacted at the same time. This difference makes it extremely important that the architecture of the mobile probe system should not have any mechanical hitches when it comes to positioning the probes. It should also be able to carry out any functional check of the component integrated into the PCB, without mechanical or electrical limitations.

Software for Checking

When it comes to testing systems, it is also essential to have integrated software able to manage the generation of all the necessary tests automatically and with the right parameters. This is even more important in the case of "embedded" PCBs, which are more complex. The

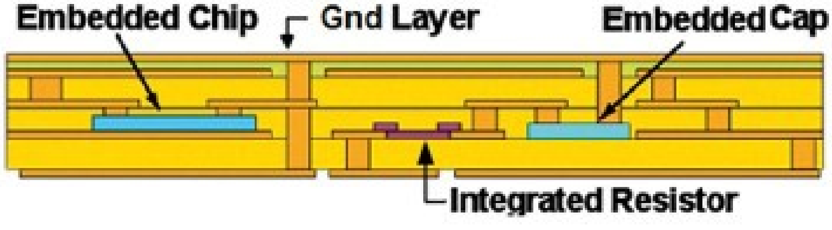

Fig. 2 - Diagram of components incorporated into a PCB

Fig. 3 and 4 - Examples of ceramic PCBs with embedded components

test programme generated on the basis of the netlist from the CAM station must be able to test and check the PCB totally, including in its embedded functions. These functions are carried out by passive components, such as resistors, inductances and capacities, as well as by active components like tension regulators, Mos/Transistors, Zener diodes, but also by properly integrated circuits.

Passive components are checked by measuring their theoretical value. Active components (transistors, diodes, Zeners and tension regulators) are checked by stimulating their entrance and measuring their exit.

Checking embedded integrated circuits is another matter. Checking these components can turn out to be much more complex. For, besides checking their connection to all the pins, it may be necessary to check their functionality too.

To be able to check that an integrated circuit is really connected to the relevant nets, it is necessary to measure the internal diode connected between each pin of the component and the mass reference of the actual component (**Fig. 5**). To be able to check the functionality of the component, on the other hand, it is necessary to feed it so as to stimulate its entrance and check the respective exit.

To do all this the system ought to have the software and hardware resources to feed a logic port and to map its fiducials. Better still would be to have a completely guided graphic environment to be able to carry out a test according to specific functionals supplied by the actual constructor.

What is certain is that the PCB world has changed profoundly and, with it, the demands of the electrical test.

It is strategic to have a mobile probe system for PCB tests that can meet the new and fluctuating demands of the electrical test. At the same time, however, these systems should bear in mind what the market requirements, in constant evolution, of the next few years might be.

The Rapid Line

Seica's family of Rapid systems (www.seica.com) for PCB tests offers high performances in productivity and measuring potential. Rapid 280 is equipped with eight completely independent probes allowing it to achieve up to 9000 hits a minute. With four probes on each side, the machine takes precise measurements on both sides of the circuit. With this system all types of test can be carried out: standard tests, Kelvin test, measurement and testing of active and passive embedded components. The high productivity of the Rapid 280 system can be used with excellent results on production lines with the aid of the integrated automatic conveyer. Alternatively, its productivity can be increased by combining the system with the automatic loading and unloading module. Ideal for testing internal layers, including in-circuit testing of embedded components, ceramic circuits, flexible boards and printed circuits, it has a vertical design with eight completely independent mobile probes and a test area of 540×610 mm. The machine carries out the high tension and high impedance insulation test and has precise contact on small pads and

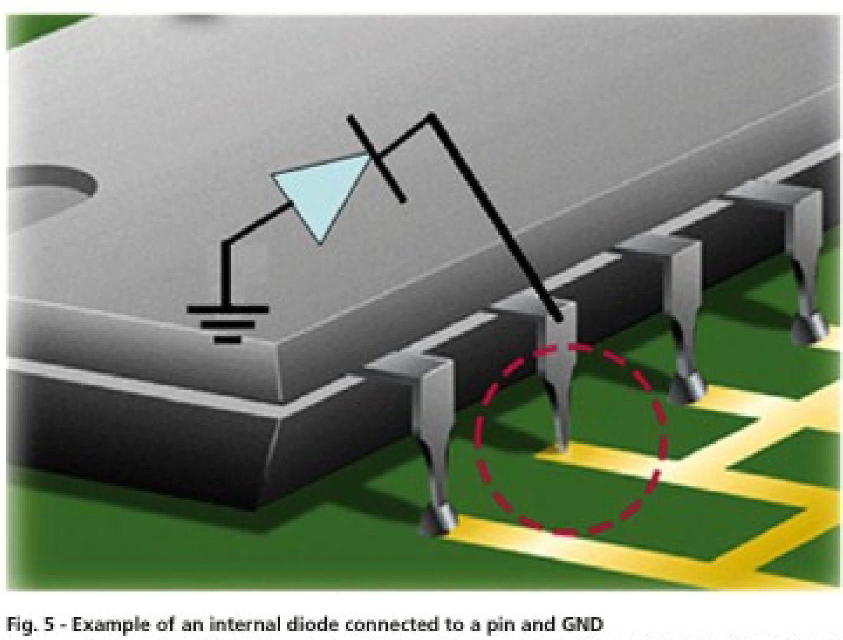

Fig. 5 - Example of an internal diode connected to a pin and GND

fine pitch with soft touch.

To meet all the demands of the market, Seica has introduced two new systems with horizontal architecture for testing ceramic substrata. As most ceramic circuits have test points on one side only, the Rapid 250/230 line's systems are equipped with four probes, all on the top side. These kind of systems combine speed and precision, typical of all the line's systems, with simple creation of a program designed to test ceramic circuits, even those with embedded components inside.

The Rapid 230 system has a manual system for fixing the board and is suitable for testing prototypes and low volumes.

With its "passthrough," SMEMA-standard conveyer, the Rapid 250 system can be inserted into a completely automatic production line to support high production volumes.

The Rapid 250/230 systems can position all four measuring probes on the same pad. Thanks to the third generation linear guides, these systems can reach high speeds while guaranteeing maximum precision and repeatability of the measurement. They are equipped with innovative measuring probes, which can carry out both traditional tests – such as measurements with two wires – and the Kelvin test (with four wires) for testing the latest materials used in making PCBs.

The test area in the Rapid 250 system is 540×610 mm. In the Rapid 230 model it is 500×396 mm.

Seica's test systems share the same hardware platform and the same software: the VIP platform and the VIVA software.

Through a series of automated operations, the operator is guided in a simple and intuitive environment, drastically reducing programming time and cutting out any chance of error.

The extremely open architecture of the VIP platform allows easy integration of external software and hardware modules for special applications (via RS232, USB, GPIB and PXI/VXI). When necessary, Seica's systems can also be driven by alternative software packages such as Labview, LabWindows and TestStand by National Instruments. All these are controlled directly by VIVA software.

The combination of different methods in one test program optimizes testing of very complex products, and means that the same test systems can be used for products with different requirements. The close integration between hardware platform and software suite allows the migration of test programs between the different testing systems. Thus, it is possible to pass from the prototype test to the large volumes test without the need to create any further programs.