PCBs: COMING OF AGE?

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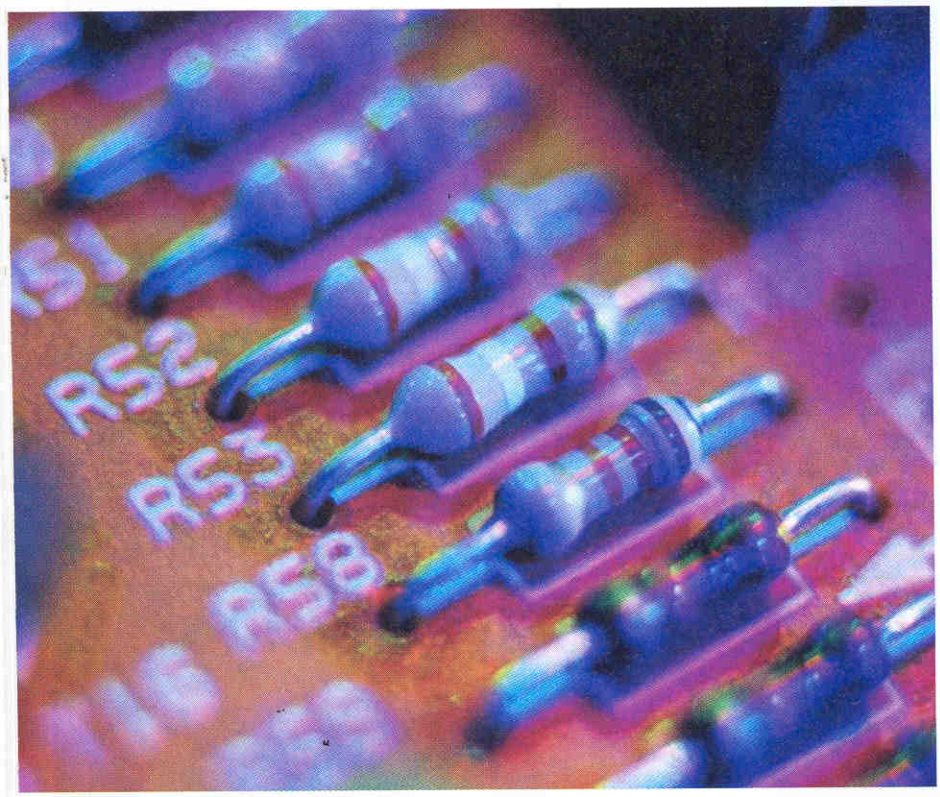


■ **UMA GUPTA**

Handheld devices like cellphones that we use today would be impossible without a printed circuit board (PCB). Even televisions and radios would be very different without them.

PCBs allow manufacturers to connect together all the parts that make up an electronic device very quickly and at a low cost. These have led to the level of miniaturisation we have today—cellphones, pocket-sized CD players and digital watches.

Manufacturing in India

Pranav Shah, vice president-FPGA & systems engineering, eInfochips, informs that manufacturers in India are producing a wide range of printed-circuit boards (PCBs) including single-side, double-side, flexible, rigid-flexible, and multiplayer PCBs. Between 10 and 15 manufacturers are producing multilayer PCBs.

The industry has numerous single-side and double-side PCB manufacturers because these types of PCBs do not require huge investments or specialist technologies. Few companies are producing flexible and rigid-flexible PCBs because there is no demand for them in India.

The Indian Printed Circuit Association (IPCA) estimates that total PCB production stands at about 15 million sq.m per annum and this figure is expected to hit around 50 million sq.m by the end of 2008. The PCB industry in India is growing and is expected to reach a yearly turnover of about $450 million in another three years.

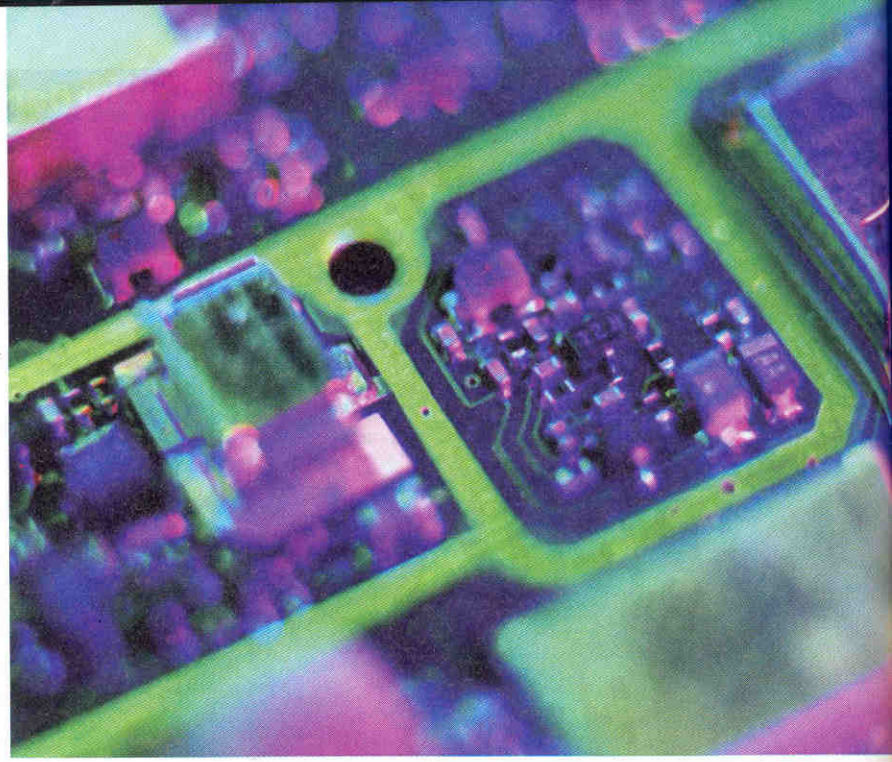
The big demands for PCBs come from consumer, industrial and automotive electronics markets, as well as from telecommunications. Multinational companies are also contributing to this demand by securing their needs from the domestic market.

India is exporting about 45 per cent of its production to the US, Germany, Malaysia, Australia, Belgium, the Netherlands, the UK, Italy, Spain, Thailand and New Zealand.

Praveen S. Jambholkar, director-technical at Cybermotion Technologies, says that in India, many companies do PCB designing up to 24 layers. A successful PCB design requires expertise over digital logic design, layout design, etc. Design companies at Bangalore, Chennai and Pune are well capitalising on their capabilities in this space.

S.L.N. Murthy, CEO of AT&S ECAD Technologies, says that though there are many manufacturing plants that can handle multilayer designs, few can address the growing need for high-density interconnects structure. PCB manufacturing in India has come of age, but it is still unable to reach the levels of design technologies demanded by the electronic system designers.

Primary applications for which PCBs are being made in India include telecom, industrial control, entertainment electronics, automotive electronics (partially) and power electronics. Requirements for rigid-flex circuits, flexible circuits and high-density interconnects are still not addressed by



Indian manufacturers.

From the volume point of view, weighing scales and inverters have been big markets till now. CNG gas conversion kits seem to be the upcoming market, says Hemant Savla, Flexi Circuit.

Majority of the applications call for smaller feature sizes (commonly referred to as trace widths, trace spacing and drill sizes) as well as higher aspect ratios. PCB layer count of 22 to 24 is common, but not every manufacturer can address these requirements.

PCBs capable of operating at gigahertz speeds are still not produced in India. The Indian PCB manufacturing industry is yet to catch up with the demands of today's portable applications with highly dense interconnection structure.

Design steals the show

In electronics, PCBs are used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive substrate. Notebook-use PCBs are the most promising ones.

Shah says that India is quickly emerging as a strong design services and R&D destination for ASIC, FPGA, board and embedded systems design. Design services majors as well as multinational companies are all doing more design work in India. In 2006, India is well on its way to becoming a leading player in electronics design.

Currently, lot of manufacturing happens in Taiwan, China and other countries like Malaysia. However, with players like Flextronics and Solectron already having base in India, we will see a rapid growth in manufacturing as well.

The rapid growth of personal computers, digital cameras, smart cellphones and wireless communication requires chip-scale electronics to meet the form and functions of next-generation electronics. The demand for array packages—ball-grid arrays (BGAs), CSPs and new version of pin-grid arrays (PGAs)—is growing rapidly.

However, Murthy feels that PCB design in India is still an extension of the drafting activity. Little emphasis is given to design for manufacture and testability. Diminishing product-cycle times demand 'right designs the first time.' This is the need of the hour as delays in design realisation impact the product life-cycle time on the shelves, thereby bringing down the overall profitability to the industry. Only few of the design services companies address this need.

Challenges before designers

Designers need to focus on low-cost approaches to pack higher performance and greater functionality into smaller packages. Apart from multilayer boards, they select smaller-footprint SMD packages to reduce floor space on the board.

Murthy says that the design process should be aimed at ensuring overall cost reduction for the final product. The design process is a very interactive process and calls for team work. This collaborative approach requires the electronic system designer to work closely with the PCB designer to achieve the desired performance. AT&S ECAD Technologies has completed a number of designs using this approach.

Handling mixed technology

Designers face interference while handling mixed technologies. They need to exercise extra care for extended temperature effect while working with mixed technologies. These issues should be tackled right at the design level through signal-integrity analysis of the board.

Murthy says that when integrating different technologies, the designers need to minimise the infusion of noise into the analogue/RF areas of the design. Digital signals today switch at a very high speed and this invariably would infuse noise into the ground and the power structures. A lot of interaction is required between the system designer and the PCB designer to have a mixed-technology design to be fully validated and ensure that it works at the time it is plugged in.

At AT&S ECAD Technologies, the design workflow is clearly defined. Proper planning of the component placement and build of the PCB to suit the manufacturing requirements, coupled with signal integrity and performance analysis, ensure the desired functionality.

Challenges in wireless product design

Wireless applications generate more interference and it is very important for PCB designers to understand the

impact of this interference. Wireless and RF design technologies need to ensure proper grounding structures and also adequate isolation from/to other susceptible portions of the design.

Here, the PCB designer has to analyse each of the elements, partition the design into rooms and ensure that each room is isolated from functionality as well as connectivity. This will ensure that noise filtering takes place throughout the design process. The room approach will also ensure ease of functional validation of the design during testing. Specific manufacturing requirements for RF design should be addressed at the design stage.

Rahul Arya, marketing director at Cadence Design Systems, informs that manufacturers of wireless communication devices are increasingly turning to system-in-package (SiP) design to help them squeeze more functionality into less space in a competitive time frame. One reason is that SiP implementation allows a high degree of flexibility in package architecture, particularly for RF applications. It also allows for lower power and less noise, and flexibility in mixing and matching IC technologies. Additionally, relative to SoC, SiP modules can generally be created more quickly.

Another advantage of SiP includes the ability to incorporate combinations of digital ICs, logic ICs, RF ICs, passive components and mechanical parts—that creates some of its greatest challenges. These challenges include the need for multitechnology simulation at the top-level, dedicated modeling techniques for integrated passives, and complex signal integrity and power delivery verification capabilities. The next-generation wireless systems promise to be even more complex as systems must be multistandard and reconfigurable.

Cadence has recently introduced an RF SiP methodology kit that accelerates the application of advanced EDA technologies to SiP designs for RF/wireless applications. It provides methodologies that maximise design productivity and predictability for customers leveraging the advantages of SiP implementation.

CAD tools in demand

Murthy divides the CAD tools for PCB design into high-performance and standardised categories. According to him, CAD tools from Cadence and Mentor aptly fit into the first category. Their focus is to provide a total interconnect solution from silicon to silicon level rather that just looking at the PCB as a single entity.

Other CAD tool vendors also address the demands for high-performance designs but lack the goal-driven solution approach. In other words, the designer does not get an insight into the design process validation during the design stage itself. Many a time it needs multiple iterations that call for going back and forth between the various stages of the design process.

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Cadence OrCad Capture and Allegro tools are widely used. Integrated design tools that provide seamless interface among schematic, layout, signal integrity analysis and thermal analysis phases are preferred.

The Cadence Allegro platform is an integrated solution created to deliver the productivity and economic benefits of the co-design methodology. Built on a common interconnect database and a shared constraint management system, it allows collaboration across design domains.

The Cadence Allegro platform delivers scalable solutions to address every complexity of PCB design, package design and co-design between IC and package and between package and board. Allegro is specialised in providing leading-edge, high-speed solu-

tions for all levels.

Constraint-driven design is one of the challenges of PCB design, and one of the reasons that Allegro has become the *de facto* standard in the industry is its tight integration throughout the design flow with its constraint management system. This again helps in first design success.

Technological trends

Arya says that end customers are expecting feature-rich, small products, leading to miniaturisation of PCB designs. An ISA-F&S report estimates that 50 per cent designs are below ten layers. However, it is projected that the designs with more than ten layers will contribute 70 per cent of the overall design by 2010. Also, increase of wireless components in all products is expected to increase the frequency of signals that are on the board. Although 60 per cent of the current design starts are less than 250 MHz, by year 2010 85 per cent of the designs are likely to be more than 250 MHz.

Flexi Circuits manufactures 6- to 8-layer rigid-flex PCBs for aerospace and medical applications. It is now able to manufacture 'sculptured flexible PCBs' using a hard thick-end finger and raised pads that help to solder the components easily.

Savla says that Indian designers tend to visualise the PCB as a flat, rigid, rectangular board and use wires to connect to sensors, actuators, etc. Soldered/crimped wiring takes time, and there can be wiring error. It is also tough to control impedance on these wires. Flexible PCBs can solve all these problems; you can actually design a 3D PCB that fits in the product case with no hanging wires.

AT&S, the parent company of AT&S ECAD Technologies, is the largest PCB manufacturer in Europe. It has a very large R&D network and works in collaboration with many research and educational institutions. Highly sophisticated designs, like composite construction and HDI designs, have been realised at AT&S plants. PCB structures with embedded passives like resistors and capacitors inside the PCB have been built on an evaluation scale. It expects to extend to embedded chips or active devices, leading to hybridisation of the printed wiring board.

Anand Jambholkar, managing director of Cybermotion Technologies, says that the Proteus VSM from Lab Center, the UK, provides complete PCB design solution for applications like power electronics and object-oriented 3D visualisation. Proteus VSM targets at reducing the development time substantially.

The product development cycle includes schematic design, synthesis, PCB design, auto routing and layout design. It takes two to three weeks to implement the whole structure, because you require various EDA tools for each stage. With Proteus VSM, you can do schematic design, simulation, PCB design and auto routing. This reduces development time to just two iterations.

With PCB design tools available in the market, you can do everything from scratch to end: Make a schematic, put the microcontroller where you want, then program the microcontroller using a cross compiler. Once you have programmed the microcontroller, simulate it. A hex file is created. Now you can check the code in a single step or by creating break points at particular instance.

India vs counterparts

Asian PCB manufacturers continue to take advantage of their reduced labour and overhead expenses. Additionally, they benefit from their proximity to

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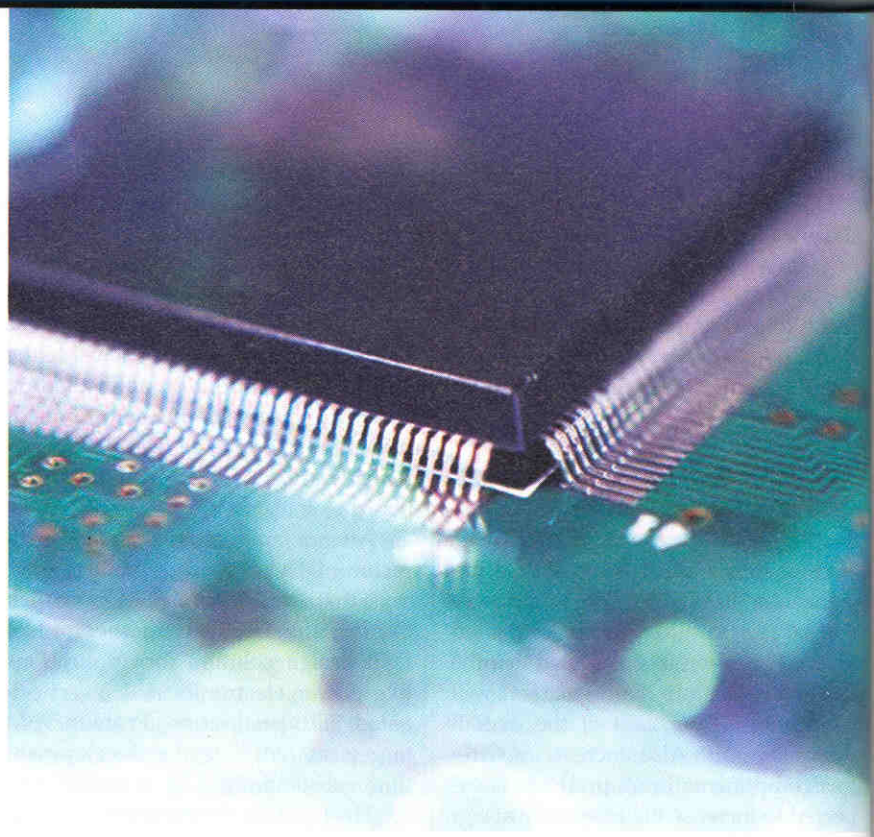

equipment production, typically outsourced in the region. But how far has India been able to capitalise on this advantage?

Shah says that Asia today accounts for nearly 80 per cent of the world's PCB production, with Europe and North America losing some share. USA has slipped from fourth to fifth place among PCB-producing countries, with 10 per cent of the world production, while the UK fell out of the top ten in 2005.

Catching up with Singapore, neighbouring rivals Indonesia and Malaysia have launched campaigns to draw in electronics manufacturers and investors. They are focusing on manufacturing ranging from foundry work to packaging and test, while presenting themselves as low-cost, hassle-free industrial destinations.

Murthy says India has not been able to catch up with its Asian counterparts for the simple reason that it has lots of overhead expenses added to operational expenses. Most of the materials like thin laminates and prepreg material are still imported. This is a bottleneck as the time to procure these materials is considerable.

High-performance designs call for various combinations of these materials to be maintained as stock to ensure timely deliveries. All these materials have to be stored in controlled environmental conditions, thereby imposing a demand for space. This would push up the costs, making Indian manufacturers non-competitive compared to their South-East Asian counterparts who can get the material just over a telephone call, thus limiting the overhead costs of storage and shipment.

India needs to have in place either an easy resource management for the materials or a central warehouse where all the materials from worldwide manufacturers are stored and available across the country.

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The future of PCB design

One of the hottest trends in PCB design is applications involving digital signal processors (DSPs). High processing speeds and programmability make DSPs uniquely suited to consumer and communication applications involving video, voice and data.

PCB design requires a critical analysis of the functionality of the various modules that go into the system. Designers must understand manufacturability constraints and high-speed signaling requirements.

The design cycle time for any product should not exceed 90 days and to meet this deadline of 90 days of product design including circuit design, it is imperative that all these processes become a collaborative process. India being a source for technical manpower, it is one of the best destinations for developing PCB design as a trendsetter of engineering services to the world. ●

The author is assistant editor at EFY