

Tape Automated Bonding, a forgotten interconnect technology?

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Scope

After the first boom during the seventies, TAB has been overruled by wirebonding as a general chip interconnect technology. But today, TAB is well introduced in Japan and features many advantages in applications like LCD drivers, high speed circuits, sensors, high pin count circuits or very low profile designs.

This paper demonstrates through various case studies the potential of TAB as an interconnect alternative and compares TAB with other state-of-the art technologies.

What means TAB?

Tape Automated Bonding is an interconnect technology between IC and Substrate, using a prefabricated carrier with copper leads adapted to the IC pads instead of single wires.

This prefabricated carrier or tape consists of a perforated polyimide film, like camera film, and of the same dimensions, which has a transport perforation and stamped openings for the IC and the connection leads.

On this film is then glued a copper foil, and this copper is structured by photolithography like a flexible circuit. The advantage of this process is the creation of freestanding fingers in the tape openings, which are then soldered or welded to bumps previously created on the pads of the IC (Innerlead-Bonding). The mounted IC can be tested, burned in and afterwards excised from the tape and mounted on a substrate like a Flat-Pack.

No mechanical protection is needed contrary to the COB-Technology, the bumps sealing hermetically the IC, and the leads showing a mechanical strength of about ten times the strength of a bonded wire.

Why TAB?

TAB was originally conceived as a rapid and robust alternative to wirebonding at a time when wirebonding was manual, and slow.

The main users of TAB at that time were Fairchild and National for the packaging of the SSI devices. The watch industry used also this process in Japan and Europe.

In the meantime, Wirebonders became automatic, free programmable and very rapid, and the initial advantages of TAB vanished at a level that this technology was mainly abandoned. Only Japanese manufacturers continued with this interconnect technology for consumer products as calculators, cameras and watches. They consequently exploited all the benefits of automatic handling for big quantities and the advantages in miniaturisation. There is also a Japanese expression created: „Keihakutansho“ meaning „light, thin, short, strong“.

Why now TAB again?

Integrated circuits have an impressive history of miniaturization, as device densities have increased several orders of magnitude. A direct consequence is a proportional increase in I/O count. This continuing trend of higher pin count and smaller equipment sizes pushes the move towards smaller packages. TAB has an important advantage against COB in the fact that pad sizes on the IC can be reduced more than a factor two for TAB.

LCD drivers take consequently this advantage for their big number of I/O's.

Still increasing clock frequencies call for minimum parasitic capacities and inductances. TAB allows bigger cross-sections for the connections and therefore reduced parasitic effects. In addition, the bigger cross-sections enhance the heat flow from the IC and contribute to achieve higher power densities. Additional heat sinks can be mounted on the free IC back. Those advantages were used for example from Intel for mounting the Pentium processors.

An important factor for the shrink of systems is the ratio between active and passive footprint. The approach at the ideal ratio 1 is accomplished by the Flip-Chip technology, but also COB and Chip Scale Packages contribute to the miniaturisation. TAB may add another advantage by combining other components with the IC on the flexible tape or eliminating additional substrates, for example by glueing the Tape directly onto a KCD or sensor.

The former drawback of TAB, necessitating bumped IC's, is relativised with today's bumping capabilities of many foundries and the venue of Flip Chip and CSP. And also the high initial costs for tooling have been revised by novel techniques in treating Polyimides, as Plasma Etching or Laser Ablation. Therefore TAB may be an interesting alternative today even for smaller production lots.

Who may need TAB?

The formerly cited properties scanned already some applications where TAB may be considered as an interesting interconnection alternative:

TQFP (Tape Quad Flat Pack) and **TBGA** (Tape Ball Grid Arrays) are novel packages using TAB as a basic interconnect.

Microprocessors and **ASIC's** benefit from TAB in the fields where high frequencies, high pin counts or high power dissipation are concerned.

Optical Encoders need a minimum distance between the optical system and the chip surface. The very robust TAB interconnection, the flat profile and the hermetic sealing give TAB many advantages.

LCD Drivers are probably best suited for TAB, combining all the assets needed:

- Flat profile (Chip thickness plus 60µm)
- High pin-count (180 - 250 I/O)
- Lowest pad pitch (actually down to 60µm)
- Automatic assembly (very high quantities)
- Flexible substrate (direct attach to the LCD)

Miniaturized systems, as Hearing aids, are easily realised with TAB, taking benefit from the combination of elements on a flexible substrate and the possibility of 3-dimensional mountings.

Conclusion

The wide spread of actual interconnect technologies makes the choice of the best suited technology very difficult. Relevant system parameters have to be taken into account already in the design phase.

Despite of some drawbacks of TAB (Bumping, Initial costs, Flexibility), this interconnect technology features some advantages for todays systems (Profile, Density) and it may be worthwhile to think about a comeback of this nearly forgotten technology.