May 2004

High Density Packaging (HDP/MCM) Newsletter

The fastest and most cost-effective route to miniaturization of electronic systems. Electronic circuitry becomes not just smaller and lighter, but better able to withstand high mechanical demands and environmental stresses.

This newsletter is brought to you courtesy of Art of Technology, the leading European HDP/MCM specialist.

Art of Technology is ISO certified and wins the prestigious European IST Price!

Advantages of HDP/MCM technologies

- shorter development times hence much faster introduction to the market.
- simple combining of different technologies becomes possible (µC, power electronics, HF, memory, etc.)
- increased functionality along with reduction in size and weight.
- increased energy efficiency.
- lower energy use.
- simpler protection from EMC and EMI is possible.
- greater reliability since a connection layer drops out.
- cost reductions at system level.
- increased modularity and adaptability of subsystems.

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Component supply and manufacturing

Does the use of HDP/MCM mean we will have to depend on a single source supplier?

- No, for every type of HDP/MCM technology there is definitely more than one supplier available, and not far away.
- Just to keep in mind: as for all processes, the recipes might differ a bit, such as required surface metallization, line/spacing width etc., so the second source issue should be tackled as early as possible in order to adapt the design to as many supply sources as possible.

Are there enough manufacturers that have HDP/MCM assembly capabilities?

- Yes there are, from prototyping to medium to highest volumes.

Why are dies so hard to get? Our suppliers always deny that the comps we use are available as dies!

- Bare dies are more delicate to handle and to assemble requiring experienced partners. Therefore, sometimes IC suppliers won't supply them directly if they don't see an experienced partner. They fear being held liable if the project fails to succeed due to a lack of know-how.
- Some suppliers, especially distributors and members of the "ordinary" sales forces simply cannot handle such requests properly themselves. So when they do not see a (in their eyes) significant annual volume, they simply turn down the request.

Cost comparison

How does HDP/MCM compare cost-wise with standard technologies?

- Depends on how you define standard technologies. Are microvias and rigid-flex or flex substrates standard to you?
- E.g. substrate surfaces for COB could cost only 10-15% in medium range volumes, **when compared to the same size!** But when the COB substrate itself is 15-20% smaller...
- Apart from COB (PCBs & Wirebond), the other technologies such as LTCC, Thin Film, TAB and Flip Chip are certainly more expensive in the prototype to low volume range. The reason is that there is no low-cost tooling infrastructure, which makes the NRE-per unit cost very high for low volumes.

For what product volumes does HDP/MCM make the most sense? Is it economical to use those technologies for small and midsize volumes?

- Do not redesign to HDP/MCM for cost savings only! HDP/MCM offers technical benefits such as miniaturization, reduced power consumption and improved performance that often also means system cost savings.
- Especially for small/medium volumes the design/prototyping/qualification efforts are the main cost contributors in the development phase. Afterwards the components are the main contributors.
- HDP/MCM cost about as much as standard technologies, so if you only redesign to HDP/MCM you will find that you have the redesign effort as a NRE-per unit penalty without reaping the benefits.

Advantages/disadvantages

Why does HDP/MCM enable companies to either build entirely new products or improve the performance of existing products?

- Due to the inherent miniaturization capabilities, product ideas once obstructed by considerations of the size and weight of their technical realization can now become a reality, e.g. the pigeon data logger, GPS in a mobile phone or a PDA.
- When the outer size is fixed, using miniaturization allows increased functionality on the same floor space.

Isn't HDP/MCM primarily used for specialized and ultimately cost-insensitive applications such as in aerospace where e.g. weight and robustness are the most important design criteria? In what applications is HDP/MCM already used?

- Automotive engine control units (wire bond on ceramics)
- Processors (Flip Chip - FC - on Ceramics)
- Cordless Phones (FC on board)
- Low Cost LC-Displays (FC on glass, Chip on Board - COB)
- Step motors , Mobile phone chargers, Watches (COB)

Are bare dies less reliable than packaged ICs? After all there must be a reason why IC manufacturers deliver them usually in standard packages.

- No, not less reliable, but more delicate to handle. But this is no problem for companies with experience in this area like AoT and our suppliers.
- Still, in order to minimize effort, we only use bare dies when a chip-size package is not a viable alternative.

Market and industry trends

Is the US and Asia ahead in the usage of HDP/MCM?

- Yes, because the type of applications developed and produced in these areas, i.e. consumer electronics and computer equipment, are in general high-volume, higher NRE cost and design effort are easier to compensate for in the long run.
- Moreover, since these application areas are driven by size/weight requirements, they benefit particularly from the HDP/MCM benefits.

How does HDP/MCM compare with an ASIC design -if at all? When does an ASIC design make more sense than using HDP/MCM?

- If you already have designed ASICs, HDP/MCM will allow you to efficiently and inexpensively use them to offer a wide range of product variations.
- When to use ASIC:
  - High Volumes > 100k/a
  - Only one technology needed (memory, power, Si, GaAs, Microsystems, etc.)
- When to use HDP/MCM:
  - Development time critical (HDP needs shorter development times and its overall time to market is quicker than that of an ASIC).
  - Low/medium volumes (lower development cost, lower NRE).
  - Applications in mixed-signal electronic systems where the different technologies (memory, power, Si, GaAs, Microsystems, etc) can't be combined in an ASIC/on a single chip.

What do industry experts say about the use of HDP/MCM?

- See **Rao Tummala and Ken Gilleo's views on HDP/MCM**

"Be flexible!" The production of Smart Labels with 25µm thin chips
Summary of article in Elektronik 3/2004, page 38-46,
by Dr.-Ing. Hans-Peter Monser and Cristof Landsberger

Until now RFID technology has only been used for application in transponder chips of between 150µm and 250µm in thickness. Now that a production process has been successfully developed for extremely thin transponder chips of between 20 and 40 microns, it is possible to laminate the chips in thin foil or to embed them in paper, and these can be used to form an electronic tag or "Smart Label". Such labels are particularly suited to the field of security, authenticating documents and guarding against forgery. The integration of silicon elements also offers the possibilility of adding and important supplementary data (e.g. adding biometric data to passports).

The production of 25µm thin silicon chips
Integrated circuits, in this case transponders, are made using silicon wafers with a diameter of greater than 200mm and a thickness of at least 700µm. After the semiconductor processing has

been completed, the wafers are ground down and polished or etched, until the silicon substrate is down to the required thickness. The most important requirements of the thinning sequence are complete stabilization of the wafer to avoid breaking, and a satisfactory technique for dividing the wafer into chips. In the project "InnoSi" (joint project for innovative preparation methods based on thin silicon elements) the transponder wafers of the producer Texas Instruments are thinned and divided according the production principle "Dicing by Thinning". Grooves are made in the front side of the wafer by sawing or using plasma etching, to the exact depth of the final thickness of the chip. Then the wafer is reversed and put onto a carrier substrate for thinning. It is thinned from the back until the grooves are open. In this way the wafer is divided automatically into chips. To transfer the chips later to a more standard carrier, it is important to use a film material that allows easy separation of the individual, ultra-thin chips.

The reel-to-reel production principle
Mass produced microelectronic articles like electronic labels require highly economical production methods, and in this respect the reel-to-reel production technique is particularly successful. The "Smart Label" module consists of an extremely flexible synthetic or paper tape which undergoes various processing steps. At each step the band is unwound from the roll to be worked on, and then rewound. Thanks to the development of multi-track bands together with simultaneous processing of multiple modules, for instance in silk-screen processing and chip-mounting stages, the reel-to-reel manufacturing technique offers the advantage of low cost together with high throughput.

Mounting technique for 25 micron chips
Chip assembly on plastic or paper supporting media with appropriate pad connections takes place through removal of the chips from a pick-up tape following transport to the assembly point, followed by transfer onto pre-applied adhesive. With Flip Chip assembly the chip is inverted before transfer. In order for the removal process (taking the chip off the pick-up tape) to work, the chip must be of a particular stiffness compared with that of the tape. In this way, when the tape is bent to a particular point the chip resists the bending force and the tape begins to peel away from it. This method of removal does not work with chips that are only 25µm thick and thus are themselves highly flexible. For chips under 50µm in thickness a new process is required. For these, the classical pick-up tape is replaced by one with a special adhesive-coated film. At a specific temperature the adhesive completely loses its stickiness. The adhesive foams up, reducing surface adhesion and peels away from the chip as the film's surface expands and blisters. The chip is lifted by the blisters to lie clear of adhesive, ready to be lifted up by the pick-up tool.

By using a time-pulse controlled heating element to heat and disturb the T-tape (the thermal-release adhesive film) in the region of the chip, it is possible to deposit several chips per second and to put them on the carrier substrate. Advantages are simplicity, efficiency, a high level of controllability due to precise control of the degree of heating, together with low capital and operating costs. Further advantages are that very large chips can be transferred by this process, and that mechanical damage to the chips in the transfer process is completely avoided.

Finally, the adhesive deposition and the placing of the chips must be adjusted. With screen printing it is easily possible to create deposits of glue of different sizes and of very homogeneous and exact thinness. With the help of a special vacuum pipette the chip is then pressed evenly and flatly onto the adhesive deposit.

Together, the utilization of T-tapes with a heating element and a miniaturized silk-screen for creating extremely thin glue deposits, along with the adaptation of pick-up tools to highly flexible thin chips, have resulted in an extremely fast and cost-efficient mounting process, offering for the first time a simple means of working with ultra-thin silicon.

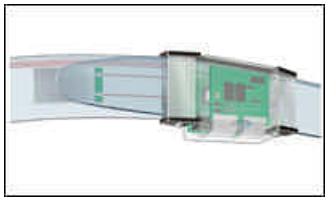
Connectivity for ultra-thin chips
Flip Chip assembly with anisotropic conductive adhesive is a widespread method of chip assembly for electronic labels. The transponder chip active side is directed in this method towards the antenna substrate. Mechanical attachment and electronic connection take place in a single procedure, in which hardening is effected under simultaneous application of pressure and heat.

In addition, ultra-thin chips make a new type of electrical connection possible: the isoplanar contact. The chip is thus stuck with its back on the carrier foil and the electrical binding is created in the silk-screen printing.

In contrast to the Flip Chip type process, with isoplanar contact the silicon chip is at same height as the conductive strips of the antenna. This brings large advantages in the reel-to-reel processing, as the chip is no longer subjected to heavy pressures.

APPLICATIONS

QBIC: The smallest computer integrated into a belt



The QBIC (Belt Integrated Computer). "Ideally, in the future computers will be an integral component of our everyday outfits - always switched on and as a result able to support us in all sorts of everyday activities." With the support of Art of Technology a computer with a complete range of functions has been developed at Zürich ETH Institute for Electronics. Its form factor is that of a belt buckle. This development platform was created with an eye on ergonomics and portability, but also maximises functionality and flexibility. The system incorporates an X-scale (Intel PXA263B1C400) processor with 32MB internal flash memory, 256MB SDRAM, a VGA port, a low-power RF transceiver, an RS-232 serial port, a bluetooth-module, a USB-socket, GPIO-pin and a memory slot for external hard drives (miniSD-Card). The plugs and the

battery are built into the belt itself. For alternative areas of operation battery modules can be used in place of the belt.

The QBIC was developed on two PCBs (SBU with microvias). The large components such as the processor and memory were used as CSP. In order to provide maximum modularity for later applications, processor and memory were mounted on the motherboard (24.2mm^2, 8 layers), and the interfaces were mounted on a extension board (14.9mm^2, 4 layers) attached to the main board by means of a flexible part of the PCB (Flex connector). Comparable systems need an area of 56-80cm^2. This corresponds to a size reduction of over 30%.

INDUSTRY AND MANUFACTURER NEWS ITEMS

Mektec: Innovative transmission control through use of flexible PCBs

In the 7G-tronic, the first seven gear automatic transmission to be fitted to Daimler-Chrysler's production passenger vehicles, Freudenberg Mektec Europa and Siemens VDO Automotive AG have inserted a flexible PCB. This replaces the scrap webs and connects the control circuitry to the transmission plug, sensors and single solenoid valves. The PCB is actually in the oil sump of the transmission and must therefore be able to withstand constant temperatures of 150°C and be stable in the face of rapid injection of the transmission oil. The flexible PCB saves space by being laminated directly onto a motherboard, and operational reliability is optimized by extremely high vibration stability.

Further information: **www.mektec.de**

straschu Leiterplatten GmbH: The longest circuit board in the world

The LongFlex circuit from straschu Leiterplatten GmbH is a flexible circuit board several metres long, whose input and output connections are supported on rigid sections. In addition, the circuit board can be protected by shielded zones. Using a special folding and fixing technology it is possible to manufacture it to any desired length with any desired number of tracks. Straschu Leiterplatten GmbH envisages applications in emergency lighting installations, in automotive manufacture, in the building services, in mechanical engineering and also in air and space technology.

Further information: **www.straschu-lp.de**

Frost & Sullivan: Good prospects for Smart Cards

Market research institute Frost & Sullivan predicts better times for the manufacturers of Smart Cards due to large demand for high-quality 32K and 64K SIM cards. In addition the introduction of GSM offers a large growth potential, as well as the growing number of new participants worldwide. Alongside this, to the migration of credit card companies from magnetic strip cards to Smart Cards may offer greater opportunities for the use of SIM cards in m-commerce. Identification and safety applications form a further important area of implementation. Of the Smart Cards delivered worldwide today memory chip cards constitute a larger proportion than processor cards, but this is likely to switch over in or before 2006. According to Frost & Sullivan processor cards will then constitute 55.5% of the total sales of 2.54 billion market.

INDUSTRY EVENTS

Upcoming Events

PCIM Europe 2004
May 25-27, 2004
Mesago, Nürnberg
Germany
Phone: +49/ 711 / 61946-56
www.mesago.de

Europäisches IMAPS Symposium 2004
June 16-18, 2004
IMAPS Prag
www.imaps.de

12. FED-Konferenz
September 16-18, 2004
Neu-Ulm
Germany
Phone: +49/ 30 8349059
www.fed.de

Deutsche IMAPS-Konferenz 2004
October 11-12, 2004
TU München
Germany
www.imaps.de

Electronica 2004
November 9-12, 2004
Neue Messe München

Germany
www.global-electronics.net

ART OF TECHNOLOGY NEWS

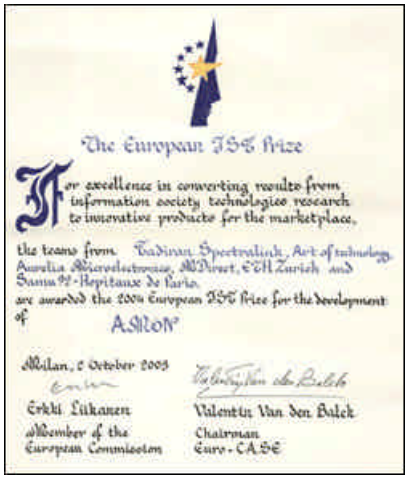
ISO certification from SQS obtained

Art of Technology obtained in September 2003 the ISO certification ISO 9001:2000 and ISO 13485:2000 (for medical applications) from SQS. This demonstrates our commitment to both innovation and best quality.

Rolf Schmid, CEO of Art of Technology commented: "Our focus has always been on achieving highest quality for our customers. This quality commitment means to a large extent the transparent and systematic documentation of all the design phases. The ISO certification -while an important milestone - is just a confirmation of this commitment. In addition it is a requirement to further grow our business and serve both small as well as largest companies.

European Information Society Prize Winner 2003

IST-Prize, Information Society Prize.
The AMON-Consortium (members are: Tadiran Spectralink Ltd. (IL), Art of Technology (CH), ETH Zurich (CH), MDirect Ltd. (IL), Aurelia Microelettronica S.r.l. (I), Assistance Publique - Hopitaux de Paris (F)) won the award by developing in teamwork a wearable health device that monitors and evaluates automatically human vital signs. It is connected via embedded cellular data-links to a remote monitoring medical center.


The European IST Prize

For excellence in converting results from information society technologies research to innovative products for the marketplace,

the teams from Tadiran Spectralink, Art of Technology, Aurelia Microelettronica, MDirect, ETH Zurich and Assistance Publique de Paris,

are awarded the 2003 European IST Prize for the development of

AMON

Milan, 2 October 2003

Erkki Liikanen
Member of the European Commission

Valentin Van den Balck
Chairman
Euro-CASE

The European IST Prize is the most prestigious award for groundbreaking products that represent the best of European innovation in Information Society Technologies. It is organised by Euro-CASE with the support of the IST Programme of the European Commission. 420 innovative projects from 28 countries competed for this year's prize, 70 European IST Prize Nominees have been selected among all applicants, and among these Nominees 20 Winners have been chosen. The selection criteria were: technical excellence, innovative content, potential market value and capacity to generate new jobs.