3D & ADVANCED PACKAGING IS NOW WITHIN REACH
WHAT IS NEXT LEVEL INTEGRATION?

Next Level Integration blends high density packaging with advanced interconnect to quickly deliver miniaturized solutions.

Going forward, ISI believes that packaging technology will play as big a role as transistor evolution in advancing Moore’s Law.
DEVELOPING IC PACKAGES SINCE 1987

KEY MILESTONES

1993
- Developed 557 I/O PPGA for 48 Watt GaAs die

2001
- Invested in equipment & clean room to provide IC assembly services

2010
- Significantly increased 3D & stacked die capabilities
IC PACKAGING 101

Die Attach & Wire Bond

Flip Chip & Underfill

ISI designs multi-die modules utilizing both Wire Bond and Flip Chip die.
3D Die Stacking

- Multiple processes qualified
- Utilize standard die - no TSVs (through silicon vias) required

Examples:

- Tiered ‘Wedding Cake’
- Same Size Die Stacked with Spacers
- Flip Chip + Tiered ‘Wedding Cake’
- Center Bond using Z-Controlled Die Attach
Thermoset Overmolding

Multiple packaged ICs, bare die, and passive components can be ‘molded’ into single, monolithic component

- Thermoset epoxy is same type of material used in standard BGA and QFP packages
- Does not melt or soften during subsequent reflow processes
- Ultra-fine particle size can underfill BGAs and flip chips and also provide wirebond encapsulation

Ideal for rugged environments
3D Substrate Stacking
ISI designs and manufactures high-density z-axis interconnect to facilitate stacking of thin substrates

- 0.4mm pitch and above (area array)
- Precision dimensions / thin walls minimize keep-out area

Stacked Substrates using Bare Die

Stacked Substrates using Packaged Devices
ADVANCED PACKAGING EXAMPLES

System in Package
45x45mm BGA
2 Flip Chip Die
3 Wire Bond Die
2 Packaged ICs
Multiple Passives

Final assembly is a BGA package with heat spreader
ADVANCED PACKAGING EXAMPLES

Atom + DDR3 Module
40x45mm BGA
(1) Intel Atom Processor
(9) SDRAM DDR3L x8 (x72 bank)
Integrated Heat Spreader
Overmolded for High Reliability applications

Final assembly is a BGA package with heat spreader
ADVANCED PACKAGING EXAMPLES

System in Package (SiP)
4 Die Stack:
• Processor
• DDR
• Flash
• ADC
VR Die & Passives
HiLo Connector for Stacking

22x22mm Module
Shown prior to encapsulation
ISI FC512 CONFIGURATOR

BGA Package
- 13x13mm body size
- 9 die module
- 224 balls
- 0.8mm pitch

13x13mm BGA

27-Up Array

9-Up Array
ADVANCED PACKAGING EXAMPLES

Micro FPGA Compute Node
Flip Chip FPGA Die
(2) Multi-Die DDR3 packages
Power management
Card Edge Interface
ADVANCED PACKAGING EXAMPLES

32 Node Compute Cluster

Each Micro FPGA Compute Node is enclosed in a heat spreader.

32 nodes are inserted into water-cooled Master Module.

Master Module interfaces to system board through custom 2368 pin ISI HiLo socketing system.
ADVANCED PACKAGING EXAMPLES

Chip on Flex
- 3 wire bond die
- Passives
- Embedded in smart credit card

Chip on Rigid-Flex
- Dual die design
- Flex portion allows 90 orientation of sensors
ADVANCED PACKAGING EXAMPLES

High Density Memory Module
5 DDR3 Die
Long wirebonds to reach center-of-die pads
ADVANCED PACKAGING EXAMPLES

Liquid Crystal on Silicon (LCoS) Package

Large LCoS die (30mm+)
Precise mechanical tolerances to provide alignment to optical system
Very flat heatsink (± 0.0005") to prevent image distortion
Material set Engineered to be stable over operating temp range
High volume cost-sensitive application
**Multi Die Module**

9 die in module smaller than credit card

Less than 20% of the size of discrete component design
HIGH-DENSITY MEMORY SOLUTIONS

**Five-Chip Memory Module**
- Bumped substrate is wire-bonded to memory die to make CSP building block
- Three CSP building blocks are embedded in the base
- The top substrate has BGA pads allowing for placement of two additional packaged memories
- The bottom side of module has BGA spheres for assembly to the board

**BGA Package in Package (PiP) and Package on Package (PoP)**
- BGA Package in Package (PiP) with embedded BGA
- Doubles SDRAM density in same PCB footprint

**Flash Stacks**
- Two High
- Up to 4X Density

Unique memory solution using die and packaged devices
3D DDR3 MODULE

**Customer’s Challenge**
- Customer required high density compute nodes for HPC application

**ISI’s Solution**
- Placed overmolded 3D-DIMM modules on bottom side of PCB, directly under the FPGA
- Eliminated 14 layers on customer PCB by mapping 3D-DIMM module pin-out directly to FPGA pins, connect by through-hole via
- Lower profile design increased airflow, and allowed compute nodes to be stacked together on a tighter pitch
- Freed up massive real estate
- Improved signal integrity by dramatically reducing trace length from FPGA to DDR3

**Images**
- Side View of 42.5 x 42.5 mm FPGA
- Cross-Section of (4) 24 x 24mm 3D-DIMMs
- 4 Memories on Topside of Module
- Heat spreader can be added to center of module if required
- Void-free overmold / underfill between module substrates
- 4 memories on bottom of top board
- 1 memories + register + misc on top of bottom board
- Heat spreader can be added to center of module if required
- Void-free overmold / underfill between module substrates
MMCM: MOLDED MULTI-COMPONENT MODULES

- Complex, multiple components integrated in a single module
  - Bare or packaged die + passive electronic components overmolded with thermoset epoxy
- Ideal for miniaturized, rugged applications in harsh environments
- An affordable way to ruggedize electronic modules
- Modules can be designed to directly replace obsolete devices
MULTI COMPONENT PACKAGES

Internal components include:
- Modern FPGA in small BGA package
- Level translators for IO
- Voltage regulation
- Decoupling caps, etc.
## Customer’s Challenge

- Avionics customer faced obsolescence on part, needed alternative IC package
- Redesigning avionics main board would mean requalification
- Due to high temp and vibration requirements, a standard non-overmolded adapter would not be an option

## ISI’s Solution

- After in-depth cost analysis, customer determined it would be more cost effective to design an ISI overmolded 40-pin DIP package to replace current IC package
- The rugged overmolded design consisted of off-the-shelf packaged parts on an FR4 PCB with ISI lead frame pins
- Non-molded prototypes delivered and tested within 4-6 weeks
- Molded prototypes met customer qualifications and delivered within 2 weeks after approval
- ISI solution flexible to meet any of the customer’s future redesign issues
THANK YOU!

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