Advanced Technologies for System Integration

Leveraging the European Ecosystem

Presented by
Jean-Marc Yannou
ASE Europe
June 27, 2013
Outline

- Introduction to ASE Group
- Evolution of the European semiconductor market
- Examples of modules realizations at ASE Group
- System integration via advanced packaging technologies
  - Examples of advanced technologies at ASE for system integration
- Leveraging the European Ecosystem
  - Technology partnership
  - Supply chain and business models
- Conclusion
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ASE Brief History

- Established 1984, production commenced at flagship factory in Kaohsiung, Taiwan
- Achieved global market leadership in 2004, surpassing all players in OSAT industry
- Operations now at 12 facilities worldwide, serving multiple markets, applications, & geographies
- 50K employees: Global team comprises operations, engineering, R&D, sales, & marketing
- Reported revenues of $4.4B in 2012, about 13% in Europe,
- ASE in Europe is 40 employees including 7 engineers/PhD’s for local tech support
ASE Group: Business Units

Chairman
Jason Chang
Richard Chang

- ASE ATM
  - Tien Wu
    - COO
  - 2012 revenues: $4.4B

- USI
  - Sam Liu
    - CEO
  - 2012 revenues: $2.1B

- Real Estate
ASE group’s Role in the Manufacturing Value Chain

Unique for an OSAT!

- Material
- Assembly
- Wafer Bumping / Probing
- Foundry
- Engineering Test
- Integrated Circuit Design
- Module, Board Assembly & Test (DMS)
- Final Test

Services Offered by ASE Group
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Evolution of the European semiconductor market

- European Semiconductor players are refocusing from high volume wireless consumer to value-adding **high end, safety and quality** applications

  - Electronics for end **applications with ‘more than electronic’ content**
  - **Integrated System Modules are key**

### Industries

- **Automotive**
- **Home automation**
- **Banking, security**
- **High-end consumer**
- **Industrial**
- **Medical**
- **Aerospace**
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Wireless SiP Module

A fully functional subsystem which includes the following features...

1. One or multiple ICs
   - CMOS
   - BiCMOS
   - GaAs

2. Components are incorporated:
   - R/L/C
   - Filters (SAW/Balun/Band Pass)
   - Memory: EEPROM / Flash
   - Crystal
   - Switch

3. Chip-level Interconnection:
   - Flip-Chip
   - WLCSP
   - Wire-bonding

4. Carrier:
   - Laminate (BT/FR4/FR5) Substrate
   - LTCC (Ceremic) Substrate
   - Leadframe

5. Shielding:
   - Metal Lids
   - Conformal Shielding

6. Structure:
   - MCM side-by side structure (Single side assembly)
   - 3D Cavity structure (Double side assembly)
   - 3D Die Stacking structure
   - Embedded structure
Focus Markets: Wireless Connectivity & Cellular RF

<table>
<thead>
<tr>
<th>PA Module</th>
<th>PA Module</th>
<th>PA Module</th>
<th>Transmit Module</th>
<th>Transmit Module</th>
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<tbody>
<tr>
<td>![Image]( PA Module 1)</td>
<td>![Image]( PA Module 2)</td>
<td>![Image]( PA Module 3)</td>
<td>![Image]( Transmit Module 1)</td>
<td>![Image]( Transmit Module 2)</td>
</tr>
<tr>
<td><strong>Module Size (mm)</strong></td>
<td><strong>3 x 3 x 1.0</strong></td>
<td><strong>5 x 4 x 1.0</strong></td>
<td><strong>5 x 5 x 1.1</strong></td>
<td><strong>8 x 8 x 1.1</strong></td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>Single Band UMTS (3G)</td>
<td>Dual Band UMTS (3G)</td>
<td>Quad Band GSM / GPRS / EDGE</td>
<td>Quad Band GSM / GPRS / EDGE</td>
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<tr>
<td>Front-End Module</td>
<td>![Image]( Front-End Module 1)</td>
<td>![Image]( Front-End Module 2)</td>
<td>![Image]( TRX Module 1)</td>
<td>![Image]( TRX Module 2)</td>
</tr>
<tr>
<td><strong>Module Size (mm)</strong></td>
<td><strong>7 x 4 x 1.0</strong></td>
<td><strong>7 x 4 x 1.0</strong></td>
<td><strong>9.3 x 9.3</strong></td>
<td><strong>9.3 x 9.3</strong></td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>Dual Band UMTS (3G)</td>
<td>Dual Band UMTS (3G)</td>
<td>Tri Band</td>
<td>Tri Band</td>
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</table>

<table>
<thead>
<tr>
<th>WLAN Module</th>
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<th>WLAN Module</th>
<th>WiMax Module</th>
<th>GPS Module</th>
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<tbody>
<tr>
<td>![Image]( WLAN Module 1)</td>
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<td>![Image]( WLAN Module 3)</td>
<td>![Image]( WiMax Module)</td>
<td>![Image]( GPS Module)</td>
</tr>
<tr>
<td><strong>Chipset</strong></td>
<td>Single Chip</td>
<td>Single Chip</td>
<td>Single Chip</td>
<td>Single Chip</td>
</tr>
<tr>
<td><strong>Module Size (mm)</strong></td>
<td><strong>7.0 x 7.0 mm</strong></td>
<td><strong>9.0 x 9.0 mm</strong></td>
<td><strong>8.2 x 8.4 mm</strong></td>
<td><strong>15.8 x 15.1 mm</strong></td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>802.11 b/g/n</td>
<td>802.11 b/g</td>
<td>802.11 b/g</td>
<td>WiMax</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>WLAN + BT Module</th>
<th>WLAN + BT Module</th>
<th>WLAN + BT + FM</th>
<th>WLAN + BT + GPS</th>
<th>WLAN + BT + FM + GPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image]( WLAN + BT Module 1)</td>
<td>![Image]( WLAN + BT Module 2)</td>
<td>![Image]( WLAN + BT Module 3)</td>
<td>![Image]( WLAN + BT Module 4)</td>
<td>![Image]( WLAN + BT Module 5)</td>
</tr>
<tr>
<td><strong>Chipset</strong></td>
<td>Single Chip</td>
<td>Two Chips</td>
<td>Single Chip</td>
<td>Two Chips</td>
</tr>
<tr>
<td><strong>Module Size (mm)</strong></td>
<td><strong>9.5 x 9.5 mm</strong></td>
<td><strong>9.0 x 8.0 mm</strong></td>
<td><strong>8.2 x 7.7 mm</strong></td>
<td><strong>15 x 10 mm</strong></td>
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<tr>
<td><strong>Application</strong></td>
<td>802.11 b/g + BT2.0</td>
<td>802.11 b/g + BT2.1</td>
<td>802.11 b/g + BT2.1 + FM</td>
<td>802.11 b/g + BT2.1 + GPS</td>
</tr>
</tbody>
</table>

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QFN Based Power Module Roadmap

Interconnection methods:
Die attach: conductive epoxy or solder
Bonding: Au, Cu or Al wire, Al-Ribbon, Cu-clip, Flip Chip
MOSFET Power Module

For electric bicycle: molded housing, DCB, solder die attach, Al wirebond, ...
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ASE Group Assembly & SiP Module Capabilities

- Wafer Grinding
- High Density SMT
- Bumping / Wafer level
- Flip-Chip or W/B
- 3D Die stacking
- Molding
- Saw Singulation
- Enviromental Chamber
- F/A SEM, X-ray, etc..
- Mechanical Tests
- Wafer Probing
- Package Level Test
- SiP Module Test
- EVB & Socket Design
- Design Qualification
- RF Circuit Design
- Debugging & RF Tuning
- Simulation
- Packaging Design
- Design Support
- Assembly
- Reliability
- Substrate Carrier
- Testing
- Substrate Layout Design
- In-house Laminate Substrate
- Coreless Substrate
- Advanced SiP Technologies
- EMI Shielding
- Antenna on Package (AoP)
- Embedded Passives*
- Embedded Active*
- IPD*
- Metal Lid
- Conformal Shielding
- Compartment Shielding

* With partners
ASE advanced technology example 1: a\(^2\)QFN routable leadframes for modules

- Thinner
- Routable
- Power modules
- Cost efficiency (leadframe manufacturing using substrate panel lines)
- W/B, flip chip, side by side, stacked dies
- Power or RF or RF power

<table>
<thead>
<tr>
<th></th>
<th>Saw QFN</th>
<th>aQFN</th>
<th>Next generation</th>
<th>aS3</th>
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</thead>
<tbody>
<tr>
<td>Line/Space</td>
<td>100/100</td>
<td>200/200</td>
<td>30/70</td>
<td>25/25</td>
</tr>
<tr>
<td>Pitch</td>
<td>200</td>
<td>400</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Metal Finish</td>
<td>Ag</td>
<td>PPF</td>
<td>Ag</td>
<td>Ni/Au</td>
</tr>
</tbody>
</table>
ASE advanced technology example 2: conformal shielding

- Efficient RF shielding of SiPs and modules
  - Stainless steel and Copper
  - 3 to 5µm on top surface
  - 1µm on sides
  - Grounded
  - New flavors
    - Compartment shielding
    - Antenna on Package

- Miniaturization, (smaller than metal cans), higher performance, lower cost and higher integration (antenna on package and compartment shielding)
ASE advanced technology example 3: IC embedding technology aEASI

<table>
<thead>
<tr>
<th>Traditional</th>
<th>aEASI flavors</th>
</tr>
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<tbody>
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<td><img src="image" alt="Traditional" /></td>
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- **LGA Type**
- **BGA Type**
- **MCM Type**

Substrate + Embedded Die = PKG

(advanced - Embedded Assembly Solution Integration)
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ASE Partners in Europe with Technology Leaders

*Example of a module with embedded chip and Integrated passive devices*

- ASE partners with technology leaders to
  - standardize new technologies
  - offer a smooth supply chain on complex modules
  - Propose dual sourcing on critical operations
- Business models are flexible

IC die can be designed by customer or purchased by customer and consigned to ASE (SiP) or purchased by ASE (Module)

Discrete components can be purchased by customer and consigned to ASE or purchased by ASE

Module assembly and test done in ASE factories

IC

Integrated Passive Device

Substrates (with embedded Ics) can be purchased by customer and consigned to ASE or purchased by ASE or directly manufactured by ASE

IPD’s can be purchased by customer and consigned to ASE or purchased by ASE
Smoothing up the supply chain

Example embedded chip modules

Pre-assembly, wafer level preparation

Substrate Embedding

Module assembly, package finishing and testing

Tape and reel format

Strip format – agree strip standard size & substrate material

Liability

Manufacturing

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The integration of IPDia’s high density silicon capacitors the “substrate embedding” way combined with Copper pillar flip chip enable record low parasitic series resistance and inductance for high performance decoupling.

- In mass production today: 250 nF/mm² with 100μm thick
- Demonstrated in 2012: 500+ nF/mm²

- 25 and 80 nF/mm²: Si based dielectric
- 250 & up to 500 nF/mm²: Si based dielectric
- 1 μF/mm² and above: new dielectric materials and structures

Active IC

Embedded silicon IPD
Manufacturing Value Chain
With European Partners

- Material
- Assembly
- Wafer Bumping / Probing
- Final Test
- Module, Board Assembly & Test (DMS)
- Services Offered by ASE Group

PPT, Kinsus, etc.

TSMC, IMEC, UMC, GF, ...

Foundry

Engineering Test

Integrated Circuit Design

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Business Models

ASE supports a range of business models:

**Consignment**
Customer consigns most components to ASE

**Buy & Brand**
USI buys all components and owns the module

- System Value: lower to higher
- Supply chain management complexity (for customer): higher to lower
- ASE Group System liability (system design, test, software, …): lower to higher
Supporting Small Fabless

Mainly Medium, Large & Very Large Customers

ISE’s mission is to enable all fabless & startup companies with the most efficient time to market & complete supply chain solution from IC test program development, substrate/leadframe design, packaging & testing, as well as for Systems Products. Integrated Solutions Enterprise Europe intends to be an extension of our customers’ supply chain operations.

Created a wholly owned subsidiary to specifically to service small customers

Small Customers with Innovative Ideas
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Summary & Conclusions

• System integration is key to the European Electronic and Semiconductor industries

• To serve this market, 2 conditions are requested
  ● A wide range of advanced technologies
  ● Various agile and flexible business models

• ASE offers a wide technology portfolio

• ASE proposes to develop technology partnerships with chosen leading European companies with unique advanced system integration technologies

• ASE proposes varied business models to enable this supply chain cooperation
Thank You

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