Fan-in WLP: Market and Technology Trends

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The 4th Edition of Fan-in WLCSP Market and Industrial Trends report from Yole Développement brings:

- New **market forecasts**, extended from 2014 to 2020
- New **technology roadmaps**, from 2014 to 2020
- New **market shares** by business model, wafer size and application
- Special section on fan-in **market dynamics and disruptions**
- Complete **teardowns and reverse costing** on particular fan-in dies in 3 high-end smartphones:
  - **iPhone 6+**
  - **Samsung Galaxy S6**
  - **Huawei Ascend Mate 7**
Market drivers

- Fan-in WLP maintains its appeal as the package that can provide 2 unmatchable advantages:
  - Reduced form factor
  - Low cost
- New applications are emerging while other are declining
- Disruptions also expected in the MEMS and CIS domains
  - Leading to growth in MEMS market, stagnation in CIS market
- Technology innovation in fan-in WLP continues:
  - Die size increases
  - Bump pitch reduces

=> **Mobile sector is driving fan-in WLP production** and growing, however, a **new market driver - IoT** is on the horizon and is expected to have a significant impact on fan-in packages and the packaging industry as a whole.
WHAT’S NEW ON THE MARKET SINCE OUR FAN-IN 2012 REPORT?

Market dynamics

• **Fan-in WLP** manufacturing lines are full, more capacity is required

• The **Internet of Things** is starting to stir the packaging market
  • Fan-in is expected to have a significant role in upcoming sensors and connectivity needs
  • Packaging options are being explored as new applications arise

• **Foundry** involvement is no longer a dent in fan-in WLP production

• Increased activity of **Chinese capital** on the market
REPORT OBJECTIVES

To provide a market overview of the fan-in WLP landscape
- Emerging and declining applications
- Forecasts until 2020: Revenue, wafer count, unit count
- Identify main players and provide supply chain analysis
- Market shares by business model, wafer size and applications

To provide analysis of technology trends
- Technology roadmap
- Latest technical innovations

To assess the future development of the fan-in WLP market
- Outlook on potential disruptions: new market drivers, infrastructure, expanding business models, new entries, competing packaging solutions
- Impact on supply chain and technology roadmap
COMPANIES CITED IN THE REPORT

The semiconductor industry is facing a new era:

- FEOL transistor scaling and cost reduction will not continue on the same path they followed for the past few decades, with Moore’s law in its foundation.
- Advanced technology nodes do not bring the desired cost benefit anymore and R&D investments in new lithography solutions and devices below 10nm nodes are rising substantially.

New market shifts are expected in due time, with “Internet of Things” getting ready to take over pole market driver position from mobile.

Why Advanced Packaging?

- While FEOL scaling options remain uncertain and IoT promises application diversification, the spotlight is now turned to advanced packages for:
  - Cost reduction
  - Performance boost
  - Functionality boost
- In order to answer market demands, the advanced packaging segment focuses on integration and wafer level packages.

Advanced packaging is transitioning to high-performance, high-density, low-cost collective wafer-level packaging techniques.
• Even though Fan-in WLP accounts for only **1.5% of the total semiconductor revenue** and **4.4 % of total wafer count**, it covers **16% of all semiconductor packages**

⇒ It represents **16% of all semiconductor packages**
Transistor scaling and cost reduction will not continue on the same path – reaching sub 10nm grey zone.

**WHAT ARE THE OPTIONS?**

- **Continue with development of advanced technology nodes (follow Moore’s Law)**
- **Develop new alternative technologies/packages (More than Moore) to meet the market requirements**
Bridging the Gap Between Si and PCB Processing Capabilities

Increase in Packaging Technology Solutions

- Through hole DIP, PGA
- Surface Mount SOP, QFP, PLCC
- Ball grid arrays SiPs
- Fan-in WLP FC BGA PoP More SiPs
- Interposers 3D IC TSV FO WLP

Feature sizes of PCBs

Feature sizes CMOS

- Mature 1970
- Established 1980
- Emerging 1990
- Established 2000
- Emerging 2010
- Today
Fan-in Wafer Level Packages offer advantages over common packages

- **Over flip-chip BGA:**
  - Smaller footprint (chip surface is the only limit)
  - Thinner package
  - No substrate/interposer ➔ Shorter interconnections meaning higher electrical performance, lower cost and thinner package
  - Lower thermal resistance

- **Over fan-in FOWLP:**
  - Lower cost (no mold compound and steps associated)
  - Slightly thinner package
  - Smaller footprint (chip surface is the only limit)
FAN-IN WLP KEY DIFFERENTIATORS

- Smaller footprint and thinner package than Flip-Chip BGA
- RoHS and REACH compliant package
- Excellent electrical performance
- Simplified supply chain and manufacturing infrastructure
- No laminate substrate required
- Reliable, miniaturized high performance package
- Shorter interconnections
- Lower thermal resistance compared to Flip-Chip BGA
FAN-IN WLP DEVICES

Fan-in WLP Device Categories

- Analog & mixed signal
- Wireless Connectivity
- Opto
- MEMS & sensors

Established applications and new applications on the horizon
Fan-in WLP ICs started in 2000 in handsets, with small ESD/EMI protection/interface conditioning devices:

- at first - Integrated Passive Devices (IPD)
- and then - Larger ICs.

The main drivers are:

- Size:
  - Footprint
  - Thickness
  - Weight
- Cost
Wireless connectivity and CIS lead fan-in WLP production

Wireless connectivity, bluetooth + FM + WiFi combos, are the dominant devices in production today with fan-in WLP

They are followed closely by CMOS image sensors, RF transceivers, DC/DC converters

... and by various analog and mixed signal device types with much smaller shares

More details in the report
FAN-IN WLP MARKET FORECAST

Market Value and Growth Rate

FI WLP steady growth (7%)

Fan-in WLP total market value (M$)

<table>
<thead>
<tr>
<th>Year</th>
<th>Market value (B$)</th>
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<tr>
<td>2014</td>
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<td>2020</td>
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</table>

Total CAGR ~ 7%

More details in the report

FAN-IN WLP WAFER COUNT

By Device Type

Fan-In WLP Wafer forecast (2014-2020)
Breakdown by device type and end market

Fan-In WLP Wafer Count
CAGR 8%
(2014-2020)

More details in the report
Fan-In WLP Unit count
CAGR 9%
(2014-2020)
70 IC companies worldwide are in high volume production with fan-in
Top 10 companies are shipping > 80% of the total volume in wafer capacity
FAN-IN DEMAND

Top Design Companies

2014 Fan-In WLP Demand by design company

• Top 4 companies hold >50% of the market

• A large number of companies have market shares <1%

More details in the report

Fan-In WLP Design Demand – fabless, IDM

> 20 manufacturing companies worldwide with fan-in WLP in high volume production
Fan-In WLP is lead by OSATs

2014 Fan-In WLP capacity (300mm eq.)

- Fan-In WLP manufacturing today is lead by OSATs
- A foundry, IDM and WLP house established their place among OSATs

More details in the report
Even though Fan-In is already a mature platform, innovation continues.
COST COMPARISON

Flip Chip CSP vs. Fan-out vs. Fan-In

Fan-In continues to be the lowest cost packaging option

Relative Packaging Cost Comparison

Flip Chip

Fan-Out

Fan-in

2nd pass test
1st pass test
Back-end and finishing (sawing, placement, molding, marking, packing)
Substrate
RDL/bumping (or balling)

More details in the report
Several MEMS devices are using Fan-in WLP

<table>
<thead>
<tr>
<th>Package Types</th>
<th>Type of Packaging</th>
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<td>WLCSP</td>
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<td>3D WCLSP</td>
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**FAN-IN WLP FOR MEMS**

by Players and Device Type
MEMS Fan-in WLP Wafer forecast (300mm eq.)

Breakdown by MEMS devices

Fan-in is expected to continue to grow within the MEMS domain. New applications intended for fan-in WLP are emerging.
CIS FAN-IN WAFER COUNT

By Device Type

CIS Fan-in WLP Wafer forecast (300mm eq.)
Breakdown by CIS applications

Fan-in will run out of capability to support CIS needs

With the increase of pixel size, fan-in will run out of capabilities to support CIS requirements and will start loosing share in some markets to more performing packaging platforms. Specific applications will continue to increase production in fan-in.
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