Reverse Engineering for the Purpose of Intellectual Property Protection and Accelerated Product Development of SOC and SIP Structures

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Definitions of IP

- Intellectual Property (IP)
  - “A creation of the mind”
    - Inventions, patents
    - Circuits
    - Unique materials and processes
    - Software
    - Designs, symbols
    - ...

- IP Protection
  - Technical
  - Legal
“Don’t look at patents because you may be accused of willful infringement”

- Willful infringement is difficult to prove: the bar is high
- Statement is widely misunderstood
- Consult with your IP department or patent attorney
- Read patents and learn from them
Definition of RE

- **Reverse Engineering**
  - "A process of extracting the knowledge or design blueprints from anything man made”
  - RE = Learning
  - Product of interest must be obtained from the open market
  - RE is legal and ethical

- **Second sourcing** is a subset of Reverse Engineering

- Today’s definition of second source is a company licensed to manufacture another company’s product.
IP Protection: America Invents Act (AIA)

- **FIRST TO INVENT**
- **FIRST TO FILE**

2011

- Under AIA
  - File early, use provisional application
  - Be mindful of confidentiality (modified NDA)
  - Filing must be of high quality
    - Inventors need access to search tools (IP services)
  - Focus on the essential
Agenda

- Definitions:
  - Intellectual Property (IP) Protection
  - Reverse Engineering (RE)
    - Second Source and its Historical Perspective
- America Invents Act
- RE & IP Analysis in Product Development
- RE to Accelerate Product Development and Help Avoid Costly Mistakes
- Conclusions
Product Development Flow

**COMPETITOR**

**RELEASED PRODUCT**

- Intellectual Property (Patent) Portfolio
- Manufacturing Phase
- Protection Phase

**YOUR COMPANY**

**PLANNED PRODUCT**

- Manufacturing Phase
- Protection Phase
- Intellectual Property (Patent) Portfolio

International Microelectronics Assembly and Packaging Society

March 10-13, 2014

www.leteusa.com
RE from an IP Analyst’s Perspective

DEVELOPMENT DEPARTMENT
WANTS TO KNOW
COMPETITORS’ PRODUCTS AND TECHNOLOGIES

ANALYZE
UNDERSTAND
LEARN
CREATE
DEFEND

IP DEPARTMENT
WANTS TO KNOW
COMPETITORS’ IP AND TECHNOLOGIES

ANALYZE
UNDERSTAND
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<table>
<thead>
<tr>
<th>CONTENTS OF THE ANALYST'S TOOL BOX</th>
<th>IP ANALYSIS, IP PROTECTION</th>
<th>COMPETITIVE INTELLIGENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior art and literature search</td>
<td>Patent applications, IP protection</td>
<td>Competitive landscape analysis, identification of key features of competing products</td>
</tr>
<tr>
<td>Patent mapping</td>
<td>IP protection (discovery)</td>
<td>Guidance for engineers in new IP development</td>
</tr>
<tr>
<td>Claims analysis and claim charts</td>
<td>IP protection, preparation for litigation</td>
<td>Guidance for engineers in new IP development</td>
</tr>
<tr>
<td>Reverse engineering (RE), in-depth analysis, teardown analysis</td>
<td>IP protection (discovery)</td>
<td>Information for product definition and development</td>
</tr>
<tr>
<td>Trend analysis</td>
<td>Portfolio Research</td>
<td>Technology trends analysis for guiding R&amp;D</td>
</tr>
<tr>
<td>Patent portfolio analysis</td>
<td>Portfolio management, monetization</td>
<td>Portfolio's strength/weakness analysis for strategic technology management</td>
</tr>
</tbody>
</table>
RE in product development phase provides:
- Competitive intelligence
- Understanding of competing technologies
- Direction for R&D
- In-depth understanding of the market
- Support in product development and design validation:
  - Design/development
  - PDN analysis

RE helps:
- Accelerate product development
- Avoid costly mistakes
Agenda

- Definitions:
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Power Delivery Network (PDN) Analysis

- PDN is the path from the voltage source/regulator to the circuit block (Vdd)
- PDN is a major concern in 3D integrated structures as it impacts performance:
  - Power integrity
    - Ripple
    - Load Reg.
    - Efficiency
  - Signal Integrity
    - Noise
    - Immunity
    - Error rates
    - Jitter
  - EMI

DC-DC Conv. Module
Timely PDN Analysis: Why is it Problematic?

- Ideally, IC design validation should be done in the final PDN environment, but it doesn’t exist yet: The IC design is completed before the
  - Power Module PDN
  - 3D Module PDN
  - PCB System PDN

- Validation in three phases:
  - Approximate lumped element PDN model
  - “Representative” PDN environment >>> RE
  - Actual PDN environment
Buck Converter Example:

What can go wrong?
3D Package: PDN Reconstruction Process in 3D

2-LAYER SUBSTRATE

CPU

10-LAYER PCB
Reconstructed 3D structure in mcm file format.
Ready for 3D EM field solver analysis or L, R, C extraction

Courtesy of Bayside Design, Inc.
Input Files to 3D Field Solvers

- PCB or Substrate with IC and Passive Comp.
- 2D MCM, Standard IC Package
- 3D Stacked Die Package
- WCSP Package

CAPTURE OPTICAL 2D LAYER IMAGES, THEN RE-CONSTRUCT IN 3D

Tool: APD
Software: .brd
Format: .mcm

Tool: APD
Software: .mcm
Format: .sip

Tool: SIP
Software: .sip
Format: .mcm or .sip

3D FIELD SOLVER EDA TOOLS: SIGRITY (CADENCE)
ANSYS ECAD: Siwave-DC, Q3D, Silicon Frontline R3D, ...
Conclusions

- RE is a legal and ethical process.
- Inventors need to be aware of the America Invents Act.
- RE contributes in product development and protection phases.
- Proactive PDN analysis is essential in 3D packaging.
- RE can help set the direction of R&D, reduce time to market, and avoid costly mistakes.