TRENDS IN AUTOMOTIVE SiP SYSTEMS: REVIEW BASED ON TEARDOWN OF ACTUAL SOLUTIONS
Yole Group of Companies

**Yole Développement**
Market, technology and strategy consulting
www.yole.fr

**System Plus Consulting**
Manufacturing costs analysis
Teardown and reverse engineering
Cost simulation tools
www.systemplus.fr

**KnowMade**
IP analysis
Patent assessment
www.knowmade.fr

**Piseo**
Design and characterization of innovative optical systems
www.piseo.fr

**Blumorpho**
Innovation and business maker
www.blumorpho.com

**Yole Finance**
Due diligence
www.yole.fr
OUR GLOBAL ACTIVITY

40% of our business

Europe office

Greater China office

HQ in Lyon

30% of our business

40%

40%

30%

30%

30% of our business
Reverse Costing

Teardown + Cost Analysis

Customer Specific  Catalog

Costing Tools  Training
FIELDS OF EXPERTISE

- Pressure Sensor
- Gyro/Accelero
- IMU/Combo
- Oscillators/Compass
- Environment
- Gas Sensor
- Fingerprint
- Microphone
- Light/Optic

Discrete Module
- Compound (GaN, SiC)
- Power RF

Automotive
- Consumer
- Energy
- Medical
- Telecom

WLP
- SiP
- Embedded
- 3D Packaging/TSV

Power
- LED
- Lamp
- White/Blue

IC & RF

MEMS & Sensors

Display

UV LED

Packaging

PCB

Imaging

Infrared
- Visible

Systems

SIP Conference China 2018, September 17, 2018
- Introduction

- System in Package in Automotive
  - Power Modules
  - Sensors
  - Transmission
  - RF
  - Computing
Advanced Packaging

Integration: 2D ➔ 3D

Increased functionality, performance...

Package Substrate (organic)

PCB (organic board)

Interconnect:

Bumping, Pillars, Studs, Through-silicon-via, Bump-less, Embedded Technologies...
Automotive Electronics

Source: Bosch
System in Package in Automotive

- Power Modules
- Sensors
- Transmission
- RF
- Computing
Power Modules Market

- This Market forecast shows that the market for the Power Module devices will follow a rising trend with an estimated 1.5 billion increase in the next five years.

2016-2022 Market size for power devices

<table>
<thead>
<tr>
<th>Year</th>
<th>Power IC (M$)</th>
<th>Power Modules (M$)</th>
<th>Discretes (M$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>$15,605M</td>
<td>$3,184M</td>
<td>$10,568M</td>
</tr>
<tr>
<td>2017</td>
<td>$16,095M</td>
<td>$3,457M</td>
<td>$10,944M</td>
</tr>
<tr>
<td>2018</td>
<td>$16,704M</td>
<td>$3,761M</td>
<td>$11,224M</td>
</tr>
<tr>
<td>2019</td>
<td>$17,199M</td>
<td>$4,023M</td>
<td>$11,693M</td>
</tr>
<tr>
<td>2020</td>
<td>$17,835M</td>
<td>$4,301M</td>
<td>$11,999M</td>
</tr>
<tr>
<td>2021</td>
<td>$18,416M</td>
<td>$4,529M</td>
<td>$12,330M</td>
</tr>
<tr>
<td>2022</td>
<td>$19,065M</td>
<td>$4,775M</td>
<td>$12,724M</td>
</tr>
</tbody>
</table>
Molded IGBT Modules

- IGBTs and Diodes molded in a package.
- Strong presence in EV/HEV power units (VW, Toyota, Bosch, Infineon).
Molded IGBT Modules

- Example of Internal Structure
ADI µModules

- µModules offer real SiP integration
Linear Technology µModules

- 40A DC/DC Regulator with:
  - Integrated constant-frequency current mode regulator
  - Power MOSFETs
  - 0.18μH Stacked Inductor
  - Protection circuitry
  - 5V regulator and other supporting discrete components.

LTM4636 µModule

LTM4636 µModule Cross-Sections
Linear Technology µModules

- Triple 10A Step-Down DC/DC µModule Regulator
  - Included in the package are the switching controllers, power FETs, inductors, and most support components

![LTM4633 µModule Top View & Opening View](image-url)
Infineon DrBlade – Integrated Power Stage

- ASE aEASI Packaging Platform (Advanced Embedded Active System Integration)
- Organic Substrate Process Flow Modified to Meet High Power Applications
- 2 Power MOSFET + 1 Driver
- RDL: 2+1 Layer

Infineon TDA21320 Top View, Bottom View & X-Ray View

Infineon TDA21320 Cross-Section
System in Package in Automotive

- Power Modules
- Sensors
- Transmission
- RF
- Computing

Source: Bosch
Around 50 MEMS Components in a Car

MEMS sensors for vehicle dynamics control VDC

[1] Inertial sensor
[2] High pressure sensor
[3] Inertial sensor
[4] Sensor cluster with yaw rate and acceleration sensor
[5] Low-g acceleration sensor for active suspension

Source: Bosch
Around 50 MEMS Components in a Car

MEMS sensors for vehicle dynamics control VDC

More MEMS sensors for engine management

MEMS Sensor products for engine management

1. Manifold Air Pressure MAP
2. Barometric Air Pressure BAP
3. Medium pressure sensor
4. Diesel particulate filter
5. Mass flow sensor
6. High pressure sensor
7. Tank pressure sensor

Source: Bosch
Around 50 MEMS Components in a Car

MEMS sensors for vehicle dynamics control VDC
More MEMS sensors for engine management
MEMS sensors for safety systems

Source: Bosch
TPMS: Tire Pressure Monitoring System

- Mandatory in several countries

TPMS Integration

TPMS Opening

TPMS Sensor
TPMS: Tire Pressure Monitoring System

- Freescale (NXP) TPMS

Freescale FXTH87 TPMS Package Views, Opening & Cross-Section
TPMS: Tire Pressure Monitoring System

- Infineon TPMS

Infineon SP37 TPMS Package Views, Opening & Cross-Section
Airbag ECU

- Airbag ECU uses multiple inertial sensors
Airbag ECU

Continental Airbag ECU

- 2 x Panasonic Combo Sensors (Single-Axis gyro + 2-Axis Accelerometer)
- 2 x NXP Accelerometer (Single + Dual-Axis Accelerometer)
Airbag ECU

- TRW (ZF) Airbag ECU
  - 1 x Panasonic Gyroscopes (Single-Axis)
  - 2 x NXP Accelerometer (Single + Dual-Axis Accelerometer)
System in Package in Automotive

- Power Modules
- Sensors
- Transmission
- RF
- Computing
Transmission Control Unit (TCU)

- Standard ECU
- Continental TCU

  - Double Clutch Transmission (DCT)
  - Bare-Die High-Density Interconnect (BD-HDI) substrate technology
  - 13 ICs, 10+ MOSFETs, Diodes, Passives
System in Package in Automotive

- Power Modules
- Sensors
- Transmission
- RF
- Computing
GPS IC

- Multi-die integration

Ublox GPS Chip
Vehicle Central Infotainment Unit

- Network Access Device Module (NAD)
- 2G, 3G, 4G LTE, GNSS
Vehicle Central Infotainment Unit

- Network Access Device Module (NAD)
- 2G, 3G, 4G LTE, GNSS
System in Package in Automotive

- Power Modules
- Sensors
- Transmission
- RF
- Computing
Single-Chip Module

Single-Chip Module Introduction (Source: NXP)
nepes Roadmap

Market Trend

Smaller form factor
(Based on Wafer-Level Platform)

Highly integrated Wafer-Level System in Package

Tech. Roadmap

QFP, QFN, FBGA
- QFP
- QFN
- FBGA

WLP
- Fan-in WLP
- Fan-out WLP

Fan-out WLP
- Fan-out WLP

SIP (System in PKG)
- Multi-die packaging
- System in packaging

Module Technology
- One Chip Module
  - Size: 17x14x1.4T
  - AP (ARM Cortex-A9)
  - PMIC
  - Flash Memory (16MB)
  - DRAM Memory (1GB)
  - 109 Passives

Position

nepes
Wafer level integration platform
(Micro-bump, WLP, FOWLP, Large panel Module Package)

Conventional wire bonding packaging & General WLP technology

Other OSAT

Nepes Roadmap (Source: Nepes)
nepes System in Fan-Out WLP

- System-in-Package at wafer-level
- LPDDR2 Package-on-Package Configuration
- Embedded Flash
- Embedded PMIC
nepes System in Fan-Out WLP

- Chip first type Fan-Out
- 4 Redistribution Layers (RDLs)
- Via Frame (Through Package Via) formed from a PCB panel for the redistribution of the memory but also to increase the strength of the package
And many more!
www.systemplus.fr