TRENDS IN AUTOMOTIVE SiP SYSTEMS: REVIEW BASED ON TEARDOWN OF ACTUAL SOLUTIONS
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Reverse Costing
Teardown + Cost Analysis

Customer Specific
Catalog

Costing Tools
Training
Introduction

System in Package in Automotive

- Power Modules
- Sensors
- Transmission
- RF
- Computing

System in Package illustration
Source: Amkor
Advanced Packaging

Integration: 2D → 3D

- Leadframes
- w/o IC substrates
- IC substrates-based

- QFN
- Fan-in
- Fan-out
- W/B BGA
- Flip Chip BGA
- 3DIC
- Interposer based (Si, Glass, Org)

SiP

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

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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](chart.png)
❑ Molded IGBT Modules

- IGBTs and Diodes molded in a package.
- Strong presence in EV/HEV power units (VW, Toyota, Mitsubishi TPM IGBT Module, Bosch T-PM IGBT Module, Toyota Prius DSC Module, Infineon HybridPACK DSC Module).
Molded IGBT Modules

- Exemple of Internal Structure

![Toyota Double Side Cooling Module Cross-Section](image)

![Mitsubishi TPM Module Opening](image)
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 Cross-Sections

LTM4636 µModule
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

Switching mode DC/DC converters

Inductors

MOSFETs

Controller
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
System in Package in Automotive

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- Sensors
- Transmission
- RF
- Computing

Source: Bosch
Around 50 MEMS Components in a Car

MEMS sensors for vehicle dynamics control VDC

**Source:** Bosch

[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
Around 50 MEMS Components in a Car

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

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**MEMS Sensor products for engine management**

- [1] Manifold Air Pressure MAP
- [2] Barometric Air Pressure BAP
- [3] Medium pressure sensor
- [4] Diesel particulate filter
- [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: 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

Continental Airbag ECU

TRW (ZF) Airbag ECU
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

*Bosch TCU (Source: Bosch)*
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

Cross section of Electronic Board (10 layers)
System in Package in Automotive

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Single-Chip Module

**Single-Chip Module Introduction (Source: NXP)**

- **IoT/ Graphic Hub**
  - Higher power
  - High graphic applications
  - Power management

- **Portable**
  - Linux Support – Apps Processor and Memory
  - Connectivity – WiFi and BLE/802.15.4

- **Wearable**
  - Low power
  - Ultra-small form factor
  - Lower cost Sensors
  - Connectivity (BLE)

- **Autonomous Sensing**
  - Low power
  - Low standby Connectivity
  - Small integrated systems

- **Auto**
  - Integrated systems
  - In-dash
**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
  - FCBGA
- WLP
  - 65nm
  - Fan-in 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**
- 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!

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